MANAGERIAL IMPLICATIONS OF A SYNOPTIC DECISION BASE; INTEGRATED INFORMATION SYSTEMS FOR NAVY MATERIAL LOGISTICS

by

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CHAPTER I

INTRODUCTION

Subject Area of Research

An Integrated Management Information System for Navy Material Logistics, which uses automatic data processing systems, has been a Navy goal for about ten years. The Navy initially expected to achieve this goal by 1970; however, recent studies have discovered that additional years, analysis and detailed planning, resources, and many hard management decisions will be required to develop a fully integrated and compatible information system. Based on experience during the past ten years, the Navy has also determined that a new approach is required. The Navy's experience with information systems reinforces an observation by Ralph Cordiner, when as Chairman of the Board of General Electric, he commented as follows:

> It is an immense problem to organize and communicate the information required to operate a large, decentralized organization ... This deep communication problem is not solved by providing more volume of data for all concerned, by faster accumulation and transmittal of conventional data, or by holding more conferences. Indeed, the belief that such measures will meet the ... (management information) challenge is probably one of the great fallacies in business and managerial thinking. What is required instead, is a far more penetrating and orderly study of the business in its entirety to discover what specific information is needed at

each particular position in view of the decisions to be made there.[1]

The focus of this paper is on a current Navy approach to information systems design, which conceives the functional area of material logistics as an entity composed of interdependent systems. It is hoped that information which is relative to logical relationships in the material logistic system, will be presented by this paper; and that these relationships will be constructed in a manner, which can provide a practical framework for an integrated information system.

Research Question

The primary task of a manager is to cope with change; and in order to accomplish this task the manager must be provided timely and accurate information which will permit optimum decision making. The term change is characteristic of almost every aspect of the managers environment, and the tempo of change during recent years has significantly affected the managers need to communicate and acquire information. New and rapidly innovating technologies, the development of mass communications, economic growth, and other changes have increased the demand for information; but traditional Navy management information systems have been unable to respond to the increasing needs of the manager.

The purpose of this study is to trace the requirement for a Navy Material Logistic Information System and to describe a conceptual approach which can be utilized to provide a synoptic decision base for managers of the material logistic system.

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[1] Ralph J. Cordiner, "Managerial Strategy for International Business," Speech before World Trade Dinner, National Foreign Trade Council Convention, Waldorf-Astoria, New York, November 1960, New Frontiers for Professional Managers (New York: McGraw-Hill Book Company, Inc., 1956)

In particular the study will:

1. Review the original Navy plan for an Integrated Information System.

2. Examine the semantic confusion regarding an information system.

3. Develop a conceptual model of a Navy Logistic Information System.

4. Describe and analyze the current approach to NAVLIS system design.

5. Describe and appraise the technical feasibility of an integrated information system.

Scope and Organization

This thesis was accomplished primarily by library research effort. The study of information systems is a relatively new discipline, and the Naval Supply Systems Command library was an invaluable source for information and technical assistance. Many of the ideas expressed about the NAVLIS concept are the result of discussions with various personnel, who are currently involved with the NAVLIS project, to whom the author is indebted.

NAVLIS is a research and development effort and many of the official files which were made available, represent tentative policy and proposed strategy. Although the models which have been developed and the relationships that are identified were influenced by the current ideas from the NAVLIS project, they should not be construed as the ultimate basis of Navy strategy for information systems design.

Specifically, the following limitations and assumptions are applicable:

1. The historical perspective for the NAVLIS project is oriented toward the emerging role of automatic data processing systems, and their impact on development of management information. Other influencing factors, such as organizational growth, are not directly described.

2. Attention is focused on the information aspect of the Navy Logistic Information System. Elements of the material logistic system, and other major elements of the logistic system are identified and discussed, only to the extent that they establish or clarify the role of an information system in the functional area of material logistics.

3. While considerable use has been made of general management principles, no attempt was made to explore the subject of management theory in depth.

CHAPTER II

DEVELOPMENT OF THE ADP AND INFORMATION SYSTEM

Origin and Evolution

A Navy Logistic Information System was formally established as a long range goal by the Secretary of the Navy in April 1959. The original goal envisioned the ultimate exploitation of automatic data processing (ADP) systems in an integrated Navy management information system by 1970.[2] This goal was established in an era when automatic data processing equipment was in its infancy. The last of IBM's first generation series of scientific computers had been announced in 1958, and the IBM 7090 which introduced their second generation was announced in 1959. The third generation of computers which is required to achieve many of the objectives expressed in the 1959 plan was not introduced by IBM until 1966.[3] Many of the concepts which will permit the Navy to realize the goal of an integrated information system for logistics are still under development. Progress toward the goals expressed in 1959 has nevertheless been consistent, and while it is now apparent that the

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[2]U.S., Department of the Navy, Office of the Secretary, Data Processing in Navy Management Information Systems (Instruction P10462.7), 16 April 1959

[3]Lowell Amdahl, "Computer Obsolescence," Datamation, January 1969, pp. 27-28

projected completion date will be slipped, it is also becoming increasingly obvious that the original goal is feasible.

The Navy plan for the controlled introduction and proper utilization of automatic data processing equipment for logistics information systems came as a result of the successful scientific and engineering application of computers during World War II. A Logistic Research Project of the Office of Naval Research was initiated in 1948 to investigate the feasibility and applicability of electronic computers for logistic purposes. By 1955 a Navy-wide plan was developed to facilitate the systematic evolution of automatic data processing in the functional area of logistics. The prime ultimate objective of this plan was the development of an optimal information service for Navy and Marine Corps management of resources to achieve maximum effectiveness of the Operating Forces.[4]

The original plan was based on the experience obtained by the Navy during three significant periods. In the first period from 1940-45, electro-mechanical and electronic digital computers were developed and successfully applied in the Navy for scientific and engineering purposes. From 1945-50 the Navy engaged in efforts to physically modify electronic computers for logistical application, and investigated the economic feasibility of computer utilization in an area which was unrelated to the initial areas of application. The second period culminated with the first crude Automatic Data Processing capabilities for processing Navy management information.[5] From 1950-55 there was an increasing awareness by Navy management of the ultimate potential of computers, and efforts

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[4]U.S., Department of the Navy, Office of the Secretary, Instruction P10462.7, 16 April 1959

[5]Ibid

began in earnest to acquire ADP equipment. Studies were conducted, orders placed, and policy and procedural guidelines issued.

The receipt of first generation equipment by Navy activities began about 1955 and quick pay-offs were emphasized to justify the cost of acquisition and installation. The period from 1955-59 was characterized by the initial organization and development of ADP personnel, development test and refinement of initial applications, the refinement and operational shakedown of equipment and equipment producers, and very importantly, the development of criteria and standards to judge the need, specifications and effectiveness of ADP for management. The Navy-wide plan was formally established by the Secretary of the Navy and promulgated as an instruction for Data Processing in Navy Management Information Systems on 16 April 1959.[6] This instruction provided the policy, principles and procedures for advancement and utilization of punched card, electronic and associated data processing equipment and techniques in the Navy for logistics and business administration. Although the plan was general in nature, it specified short range goals for incremental periods, and long range goals to be achieved by 1970. The completion dates for the milestones proposed by this plan (1960, 1965 and 1970) have not been achieved; however, the expectations which were identified and the objectives that were established are reflected in even the most current efforts to develop ADP and information systems for logistics systems in the Navy.

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[6] Ibid

Impact of Technology

The general plan of [illegible] proposed a decentralized "bottom-up" approach to equip and begin productive use of ADP equipment. Each management bureau and major office in the Navy was assigned responsibility for ADP systems development within their respective management control boundaries.[7]

During the period from 1955 through 1960 many managers envisioned the computer as a potential panacea for numerous administrative problems. Although there was a channel for submission of ADP systems requests and general criteria for approval of proposals, the Navy exercised no central control over information and data systems development until about 1964. This decentralized approach and the promised potential of the new technology resulted in a tremendous increase in the numbers of ADP systems in the government. The growth of computers in total for the Federal Government reflects the technological impact on the Navy in the area of logistics. The enactment of Public Law 89-306 on 30 October 1965 provided the first requirement for comprehensive information regarding the management of data processing in the Navy. Detailed statistical summaries are not available for periods prior to 1966; however, the growth of electronic data processing equipment configurations which include a central processing unit in the Federal Government does illustrate the impact of the decentralized approach by the Navy and other government agencies. The Bureau of the Budget estimates that there were two computers in the Federal Government in 1950; by 1960 it was determined that there were 531 in use by various agencies. By 1965 when initial efforts were

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[7]Ibid

made to establish more rigid central control, the number of computers had increased to 2,412. A third generation computer was on the verge of being introduced.[8] A study in 1964 of facts, trends and myths within the Federal Government concluded that during this increase in numbers of computers, the number of Federal employees as a percent of the total labor force declined. Military personnel declined from 5.4 percent of the total labor force in 1952 to 3.7 percent in 1962; federal civilians declined from 3.7 percent to 3.1 percent during the same period.[9] The scope and complexity of government functions has increased and the computer represents an additional demand for scarce management resources. Evidence that personnel resources of the Federal Government did not correspond to the growth rate of the total labor force implies that management pressures were significantly increased by the technological advances. This implication is substantiated by the McClellan Committee report on government operations in 1965 which determined that agencies of the Federal Government had obtained personnel for computer operations "... primarily by reassigning employees and by hiring inexperienced applicants."[10]

The original plan anticipated that by the end of 1960, the first crude concepts and nuclei of equipment, personnel, and techniques would

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[8] U.S. General Services Administration, Federal Supply Service, <u>Inventory of Automatic Data Processing Equipment in the United States Government for the Fiscal Year Ended June 30, 1968</u> (Washington, D. C.: Government Printing Office, 1968) p. 17

[9] Frederick C. Mosher and Orville F. Poland, <u>The Costs of American Governments</u> (New York: Dodd, Mead and Company, 1964), p. 138

[10] U.S., Congress, Senate, Committee on Government Operations, <u>The Management of Automatic Data Processing in the Federal Government</u>, 89th Cong., 1st Sess, 1965, p. 92. This is a Senate Committee Print of the report commonly known as the McClellan Report.

be available to begin a natural and evolutionary movement toward an adequate management information system for more scientific management.[11] A subsequent stage of development from 1960-65 was expected to be characterized by:

1. Completion of a special comprehensive evaluation of all experience acquired through 1960.

2. Extension of Automatic Data Processing Equipment (ADPE) experience and consequent development of technical and management personnel throughout all levels and key centers of Navy management.

3. Growing awareness and working familiarity by management of the full potential of ADPE, particularly with respect to applied management sciences.

4. Shift of emphasis from clerical applications to applications which include the development of plans, programs, budgets, schedules, and management control actions.

5. Shift in overall program emphasis from review and monitorship of plans and projects decentrally developed to more centrally developed techniques, not only in ADP applications but in a scientific approach to the design of optimal information systems themselves, using operation research and similar methods in so doing.

6. Maturity of hardware, based upon: (1) Cost, size, ease of use, speed; (2) development of a full range of information systems equipment; and (3) the extent to which various applications for ADPE use by Navy management are determined and documented.

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[11]U.S., Department of the Navy, Office of the Secretary, Instruction P10462.7, 16 April 1959

7. The development of an overall plan for an orderly transition, Navy-wide, from the heterogeneity and technical infancy of first generation equipment to a full complement of adult equipment with appropriately standard or common properties, Navy-wide.

8. The beginning of the actual transition in accordance with the plan developed in Characteristic No. 7.

The efforts of major logistic commands reflect the orientation implicit in these characteristics; however, the stage of development anticipated by 1965 has not yet been achieved. The Deputy Commander for the Naval Material Command, Rear Admiral T. J. Rudden, noted in January 1967 that the development of a formal data system had been a slow and evolutionary process. He further stated that, while the Naval Material Command closely followed the Department of the Navy's plan as initially outlined in 1959, the complexities in data and information systems design, and the high cost involved, had prevented the Naval Material Command from achieving all of the objectives identified for the 1960-1965 period.[12] Admiral Rudden also advised that experience in systems design and hardware installation through 1967 indicated that complete achievement of the objectives was feasible.[13]

The total number of computers in government use continued to increase from the 2,412 in 1965 to 3,692 by 1967. The comprehensive statistics on the government automatic data processing equipment inventory, initiated by the Bureau of the Budget in 1965, provided impressive evidence of the impact of ADPE on the Navy. The statistical compilation does not distinguish between the variety of operational environments in

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[12] RADM T.J. Rudden, USN, Management Information Systems: The Lifeblood of Management, Defense Industry Bulletin, January, 1967

[13] Ibid, pp. 11-16

which the equipment is used. Based on the scope of the logistic function, however, it would appear that most if not all of the computer systems are directly related to logistics. The Bureau of the Budget determined that in 1967, there were 16,978 man-years of effort expended by personnel in the Navy who as their principal duty were directly identified with ADP functions. Additionally, in 1967 the Navy inventory contained 644 computers at a total cost of 222.6 million dollars, including personnel and other operating costs.[14] The Navy computer inventory was the second largest of the 58 government agencies identified, preceded only by the Air Force with 1,031.

The rapid growth of computer utilization presented additional management problems rather than solutions for existing information difficulties. The Bureau of the Budget reported to the President in 1965 that "... the lack of availability of essential information on a timely basis constituted an important obstacle to attaining effective management of automatic data processing equipment in the Federal Government."[15] Three years later, Mr. Robert B. Barker, Director of Information Systems Development Division, Office of the Special Assistant to the Secretary of the Navy observed that computer dependence was one of the major obstacles to system integration.[16] Mr. Barker also advised

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[14]U.S., General Services Administration, Inventory of Automatic Data Processing Equipment, p. 17

[15]McClellan Report, p. 63

[16]Robert B. Barker, "An Approach to Achieving Overall ADP Systems Compatibility." A paper presented to the Assistant Secretary of Defense (Installations and Logistics) Conference for Review of Automated Logistics Systems, Fort Ritchie, Maryland, September 13, 1968

that the diverse computer installations presented major problems in the conversion of systems and the replacement of hardware.[17] On 30 June 1968 the Navy inventory of computers reflected an increase from 644 to 763, and the associated man-years increased by approximately 2,000 to total 19,014; the 763 computers represented approximately 500 distinct ADP systems and were manufactured by more than 9 different major manufacturers. IBM represented 28.4 percent of the total government distribution and Univac was second with 21.3 percent. Products by other major manufacturers were about evenly distributed ranging from 4 to 9 percent.[18] The Bureau of the Budget (BUBUD) estimates of increases in computers for 1969 do not necessarily reflect the final approved plans in Navy budgets; however, the projected increase for the Navy of 11 computers indicates a marked change in the planned rate of growth for computers. This general restraint on the acquisition of computers was expected by the Navy to occur in the 1960-1965 time frame, in order to facilitate a comprehensive review of experience and the coordinated development of detailed plans for the development of an integrated information system.[19]

The NAVLIS Project

The trend toward more centralized control for ADP and information systems began about 1964 with the establishment of the Office of Management Information under the Office of the Special Assistant to the

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[17]Ibid

[18]U.S., General Services Administration, Inventory of Automatic Data Processing Equipment, p. 20

[19]U.S., Department of the Navy, Office of the Secretary, Instruction P10462.7, 16 April 1959

Secretary of the Navy. As the rapid growth rate of ADP equipment utilization pointed up the need for increased control over ADP and information systems, additional organizational elements were established to provide focal points for information flows and responsibility centers for ADP system development. The Secretary of the Navy initiated action in 1967 to develop plans and procedures for the development of a Department of the Navy Information and Control System. The Navy Information Systems Branch was established by the Chief of Naval Operations in 1967 to provide a strong centralized organization for the planning and direction of Navy information and data systems; and the CNO Information Systems Division was established in January 1968.[20]

In August of 1966 a joint letter from the Commander in Chief of the Atlantic Fleet and the Commander in Chief of the Pacific Fleet advised the Chief of Naval Operations of serious deficiencies in the quality and quantity of logistics information which was necessary to maintain the Navy material logistic system. This letter expressed the fleet's need for an integrated Navy Material Logistic Information System which would coordinate the inputs of logistic data with the various requirements for information by the decision-making activities in the Navy.[21] The Chief of Naval Operations established the operational requirement for a Navy Logistic Information System (NAVLIS) in December 1967. In response to this requirement the Chief of Naval

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[20] U.S., Department of the Navy, Office of the Chief of Naval Operations, Report of the Navy Study Group for Navy Integrated Command/Management Information System, July 1968, p. 20. This report is commonly referred to as the NAICOMIS Study Report.

[21] U.S., Department of the Navy, Chief of Naval Material, Navy Logistics Information System (NAVLIS) Project Instruction 5430.38, November 28, 1968

Material designated the Naval Supply Systems Command as the NAVLIS Principal Development Activity on 15 December 1967. The Naval Supply Systems Command, as Principal Development Activity, convened a NAVLIS workshop at the Center for Computer Sciences and Technology, National Bureau of Standards, from 4 March 1968 to 16 March 1968 under the direction of Rear Admiral T. B. Owen, USN.[22]

The NAVLIS workshop discovered that the various information systems do not provide for vertical aggregation of data from the lower organizational elements into condensed information for the upper organizational elements, and that the systems are not responsive to the information requirements for management. Additionally, the requirement for information to support decision-making in the material logistic system, coupled with the unresponsive systems for providing information is a primary cause for the proliferation of data systems. In addition to the inability to move data from one system to another, the lack of data quality control, and the workload caused by redundant input requirements also present major problems for users of the various information systems.

A proposed technical approach was developed by the Naval Supply Systems Command by July 1968 and approved by the Chief of Naval Material in August 1968.[23] In November 1968, the Navy Logistic Information System was established as a designated Project under the direction of the Chief of Naval Material.[24] The scope of NAVLIS covers the entire field of logistics including maintenance, facilities, and transportation and extending from the Headquarters Naval Material Command level down through

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[22]Ibid

[23]Ibid

[24]Ibid

the operating forces. It is envisioned that NAVLIS will interface with the rest of the Navy, the Department of Defense, the Joint Chiefs of Staff, other services and industry.

The NAVLIS is expected to be the principle channel for providing information input into the Chief of Naval Operations (CNO) Command/ Management Information System for the functional area of logistics. Using the existing information systems as a base, the NAVLIS has been tasked to provide all management echelons with a Navy Logistic Information System which will satisfy information requirements for approved operations. The necessary tasks to be performed by the NAVLIS Project include the definition, development, test and evaluation, acquisition, initial installation and support of a Navy Logistic Information System. Additional project requirements include a survey report of equipment, data requirements and availability, and standardization requirements; analytical studies; plans for installation, and tests; system specifications; the development of a simulation capability; and prototype development. NAVLIS is envisioned as a total material logistics information system and relates to the functional area concerned with the design, development, acquisition, storage, movement, distribution, maintenance, and disposition of Navy material.[25] NAVLIS is also expected to provide a medium for integrating the various components of the logistic system including human and non-human resources.

The Nature of Logistics

A system can be defined as any set of objects with a relationship among the objects and among their attributes; a system may consist of

[25] Ibid

atoms, stars, switches, or laws and processes.[26] The aggregation of any interacting or interdependent group of items can be considered as a system. Various definitions of particular types of systems generally provide the identity of the objects or items which are applicable and imply a connection or interrelationship among the items.[27] In this context, the interrelationship is related to survival of the system since it is a prerequisite for the existence of any system. The concept of systems is very broad and may be applied to information, data processing equipments, transportation, supplies and other functional areas to denote the connecting factors, such as interacting forces, which establish the respective area as a system.

The concept may also be applied to logistics to indicate the interrelationship of functional areas which comprise the whole of logistics. The logistic system may be described in terms of the bits and pieces as a complex of many functions, processes, and organizations, or in terms of interrelationships among functional areas with each general grouping representing a segment of the complex whole of logistics. Former Secretary of Defense, Clark M. Clifford, described logistics in its broadest sense as the entire process which begins with research and development, extends through production, procurement, construction of facilities, supply, maintenance, and ended with disposal of surplus

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[26]Arthur D. Hall, A Methodology for Systems Engineering (Toronto: Van Nostrand, 1962), p. 60

[27]George A. Steiner, Top Management Planning (London: The MacMillan Company, 1969), p. 391

material and facilities.[28] Logistics is more briefly defined as the science of planning and carrying out the movement and maintenance of forces.[29] The Navy Logistic System incorporates the totality of all elements which interact to effect the broad activity of logistics.

The complex array of interrelated elements for the logistic system can be classified on the basis of various combinations and identified as major elements. The major elements may be identified as specific objectives of groups of processes and procedures, or groups of similar functions which are performed within the logistic system. In terms of major elements the logistic system can be described as the materials, manpower, flows of information, capital equipment, and money which set up forces that determine the survival of the logistic system.[30] Each major element also represents a system, and the material logistic system combines all of the interrelated objects based on their common relationship to Navy material. Material logistics is defined as the functional area that is concerned with the design, development, acquisition, storage, movement, distribution, maintenance and disposition of Navy material.[31]

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[28]U.S., Department of Defense, Statement of Secretary of Defense Clark M. Clifford, The Fiscal Year 1970-74 Defense Program and 1970 Defense Budget, January 15, 1969, p. 144

[29]U.S., Department of Defense, Joint Chiefs of Staff, Dictionary of United States Military Terms for Joint Usage (Washington, D.C.: Government Printing Office, August 1, 1968), p. 126

[30]J.W. Forester, "Industrial Dynamics: A Major Breakthrough for Decision-Makers," Harvard Business Review, July-August 1958, p. 52

[31]U.S., Department of the Navy, Chief of Naval Material Instruction 5430.38

On 1 January 1965, the Naval Material Support Establishment was created to provide for the material support needs of the Operating Forces.[32] The Chief of Naval Material under the Secretary of the Navy is responsible for the material logistic system; the Naval Material Command includes Project Management Offices, specific shore field activities, and six principal subordinate System Commands with designated material support responsibilities. Each of the six System Commands is a network of people, resources, material, processes, and organizations which regularly interact to accomplish vital functions in support of Navy material. The complexities of the Naval Material Logistics System are illustrated by the comments of one of the six System Commanders regarding his role and that of the Naval Supply Systems Command. In July of 1966 Rear Admiral H. J. Goldberg advised that:

> ... it is hard to see how this complex (Naval Supply System) could be called a system. But, believe me it is! There is an interaction and interdependence among all of these activities and a common purpose. Although no one organization in the Navy controls the whole complex, ... it is our influence that welds this complex into a system.[33]

The scope and complexity of the Naval Material Logistic System is further indicated by the magnitude of the Naval Material Command. Expenditures by the Naval Material Command are about 11 billion dollars per year, which is about 15 percent of the total defense budget; in 1967 the supply inventory was over 9 billion dollars and the inventory

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[32]U.S., Department of the Navy, Bureau of Naval Personnel, Logistic Support of the Navy, 1965, pp. 96-104

[33]H.J. Goldberg, "BUSANDA Problem Briefing," Presentation delivered at Chief of Naval Material Management Information Center, January 5, 1966

of real estate, property and facilities was about 33.6 billion dollars. Real estate which was under the cognizance of the NMC totaled four and one half million acres, the complex included about 550 field activities, and about 370,000 military and civilian personnel.[34] The material support requirements of the Naval Material Logistic System include weapon systems such as Polaris, conventional ammunition, petroleum, oils, lubricants, and supporting facilities, supplies and equipments. The dynamic state of these requirements is indicated by statistics for the total logistic system in the Department of Defense. During 1968 the Department of Defense made 10 million purchases. Depots processed over 800 million issues to operating units; at least 25 percent of the logistic personnel were new to their jobs, and one out of every ten items in stock was there for the first time.[35]

The Naval Material Logistic System must be managed in a manner which will provide responsive support for the needs of the operating forces. Implicit in this requirement is the need for interface between the various elements which comprise the Naval Material Logistic System as well as the need for interface between the material logistic system and other major elements which determine the survival of the Navy logistic system. The specific functions which are being performed within the bounds and constraints of the Naval Material Logistic System have become increasingly difficult to identify, and sophisticated systems

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[34]Rudden, "Lifeblood of Management"

[35]U.S., Department of Defense, The Fiscal Year 1970-74 Defense Program and 1970 Defense Budget, p. 144

analysis has discovered an increasing complexity of interfaces among related functions.[36] Improved communication capabilities have increased the information flows between the various echelons of the formal organization for management of the material logistic system, and functions that were relatively independent during the 1940's and 1950's are now interdependent.[37]

Recent studies have determined that the current formal organizational structure of the Naval material logistic system actually represent "distributions of power" and do not necessarily reflect the most desirable flows of influence; the current hierarchial structure of organizational entities has not been designed to provide the best means to communicate.[38] The Navy has devoted a number of years to the development of strong organizational elements within the material logistic system; one of the most closely guarded command prerogatives of these organizational elements is exclusive information ownership.[39] The impact of the basic organization, defined by Barnard as the systematically coordinated acts of two or more people, is becoming more apparent as the information flows within the material logistic system are increased; this impact is mainfested by the difficulties in

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[36] U.S., Department of the Navy, Report on Impact of Future Technology on Navy Business Management, May 1967, p. 71. This report is commonly referred to as the MERI Study

[37] Ibid, p. 69

[38] Ibid, p. 69

[39] Barker, "An Approach to Achieving Overall ADP Systems Compatibility"

planning and control of the respective elements in the system and the recognized need for a completely integrated material logistic information system.[40] Influence is a determining factor in the effective performance by managers; it is also a primary communicative vehicle among the various elements of the material logistic system.[41] Information is a prerequisite for the exercise of power and is a primary determinant in the survival of the material logistic system.

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[40] Chester Barnard, "Concepts of Organization" in Readings In Management, by Ernest Dale (New York, 1965), p. 190

[41] Rensis Likert, New Patterns of Management, (New York: McGraw Hill Book Company, Inc., 1961), p. 115

CHAPTER III

INFORMATION SYSTEM CONCEPTS

Data

Data is generally defined as factual material which may be used as a basis for a discussion or decision. A datum is a specific assertion about some property of a state of the empirical world that is given in some acceptable form to the manager.[1] Data may be used to denote any or all facts, numbers, letters, and symbols; or facts that refer to or describe an object, idea, condition, situation or other factors.[2] An effective information system can be described as a system which translates the continuous flow of data into significant comprehensive information.[3] Information systems for management can be identified with the beginning of commerce and are associated by some disciplines with the beginning of man.[4] The tremendous growth of the data processing

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[1]C. West Churchman, Challenge to Reason, (New York: McGraw-Hill Book Company, 1968), p. 195

[2]U.S., Executive Office of the President, Bureau of the Budget, Automatic Data Processing Glossary (Washington, D.C.: Government Printing Office, December, 1962), p. 16

[3]Robert V. Head, "Bytes and Pieces" Systems and Procedures Journal, November-December, 1967

[4]John R. Gale, "Why Management Information Systems Fail," The Financial Executive, August, 1968

industry since 1950, has resulted in a plethora of readily available data, and has frequently created the phenomenon of "mental dazzle" caused by too much irrelevant information.[5] As data becomes more readily accessible, the ability to distinguish between data and information will become increasingly significant.

In 1967, John Diebold observed that ten years earlier it had been easy to answer no when asked if computers could learn; however, within five years it became necessary to define the meaning of the term "learning" before answering the same question.[6] Automation, systems approach and other new technology and techniques have created similar problems with data, information and other terminology. Mr. Diebold predicted a day of instant information, when facts would be provided to each individual through links with big central computers.[7] Current technology has indicated that information does not necessarily increase in the same proportion as the increase in facts, and many managers may view Mr. Diebold's forecast with considerable apprehension. The individual human processes to create information provides a model for the design of automatic data processing systems, and can assist managers in coping with technological advances such as the one envisioned by Mr. Diebold.

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[5]Timothy W. Costello and Sheldon S. Zalkind, Psychology in Administration A Research Orientation (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 355

[6]John Diebold, "What Comes Next in the Computer Age" U. S. News and World Report, June 26, 1967

[7]Ibid

Research in human behavior has determined that human information systems perform several important processes prior to the development of data. These initial processes and the factors which influence them have significant implications for the design and development of a material logistic information system. The current concept of data origination is the creation of a record in machine readable form as a by-product of a human readable form.[8] However, when stimuli for the data are considered other significant processes which impact on an information system become evident. Perception is a significant factor in the way an individual responds to his environment. It can be scientifically proven that individual behavior is influenced by certain environmental characteristics. Research indicates that individual behavior is seldom a direct response to reality. Rather, it is determined by the perceptions of the individual.[9] Research also suggests that individuals have a tendency to use themselves as standards in their perception of others, perceive reality based upon previous perceptions and in a manner which will minimize cognitive dissonance.[10] These findings suggest that the human information system abstracts various data from reality, and that these abstracts are governed by the predetermined needs of the individual. The total empirical environment may not be considered as a data source for the human information system, but only particular abstracts which

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[8] U.S., Executive Office of the President, Bureau of the Budget, Automatic Data Processing Glossary, p. 38

[9] Douglas McGregor, The Professional Manager (New York: McGraw-Hill Book Company, 1967), p. 16

[10] Clovis R. Shepherd, Small Groups-Some Sociological Perspectives (San Francisco: Chandler Publishing Company, 1964), pp. 21-54

are determined by the situation and the needs of the individual; the resultant situational abstracts would provide the source for development of data. The foundation for the material logistic information system can be considered reality or the behavior of objects within the system. The first process is an abstraction of facts which are used to establish the basis for subsequent development of information. Data evolve from the second process which is the production of numbers, letters, phrases, or other forms which are designed to identify the abstracts and to facilitate communication or acquisition of information. Data do not express the total reality; they express only those aspects of reality which are thought to be relevant in a specific situation.[11]

Information

The term information may be used to describe a signal purposely impressed upon the input of a communication system; it may also connote legal proceedings by an English Barrister. Other senses for information include a numerical quantity used as a measure, and the communication or reception of knowledge.[12]

A primary characteristic of the various definitions of information is the presence of the idea of meaning. Information is a construct which describes the knowledge communicated, received, or knowledge obtained from investigation, study, or instruction.[13] Communication is

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[11] Leroy E. Noemaker, "Symbol and Myth in Philosophy" Truth, Myth and Symbol, (Englewood Cliffs, N.J.: Prentice-Hall Spectrum, 1962), p. 118

[12] Webster's Seventh New Collegiate Dictionary (Springfield, Mass: G&C Merriam Co., 1967), p. 433

[13] Steiner, Top Management Planning, p. 477

the process of sharing information, an idea or an attitude; and although information is a major part of communications, the distinction is significant in the development of an information system.[14] Communications is the conveyance of meaning among individuals or objects and refers to the total interaction process. When communicative acts are involved information may be abstract and complex, including all that is either manifestly or subliminally communicated, as well as that which is either intended or interpreted.

The idea of meaning is a distinguishing feature between data and information. Some definitions do not make a clear distinction in this manner, and define information as a collection of data or other observable phenomena.[15] The current military definition of information is unevaluated material, derived from various sources and requiring additional processing or analysis.[16] These definitions imply that information is not necessarily meaningful until it has been analyzed.

There are, however, those who argue that data collection and analysis are treated concurrently. This argument is based upon the idealist's thought that each fact of the realist also represents an idea, and that the existence of a fact is contingent upon thought about the way in which a system will respond to the fact.[17] Facts and ideas are totally interdependent, each acting as a stimulus upon the other,

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[14] Ibid, p. 476

[15] Ibid, p. 477

[16] U.S., Department of Defense, Joint Chiefs of Staff, Dictionary of United States Military Terms for Joint Usage (Washington, D.C.: Government Printing Office, August, 1968)

[17] Churchman, Challenge to Reason, p. 194

and thus together establishing as a concept, the meaning inherent in an information system. Data or facts can have positive or negative value for the manager, information only has positive value.[18] Construction of unrealistic models and nonrational behavior may be caused by facts which have negative value.[19] For a manager, information is a specific assertion that has positive value, and it is the knowledge necessary to progress from indecision to certainty about the organization of a system.[20]

Data must be analyzed to produce information, and this is a third process in an information system. The group of processes which comprise an information system are illustrated by the conceptual model provided by figure 1 and can be summarized as follows:

Behavior:	Objective reality or behavior which provides the stimuli for the perception process
Abstract:	Perception process of selecting from the total observable occurrence
Data:	Identification process using symbols, letters, etc., as representations of perceived reality
Analysis:	Association of meaning with data based on its relevancy to a system or the determination of positive value (and negative value) for a need in a specific situation
Information:	Knowledge that is communicated or acquired by the above processes.

The connection or interrelationship among the processes is established by the need for information. This need may be a basic

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[18]Ibid, p. 195

[19]Ibid.

[20]Steiner, Top Management Planning, p. 175

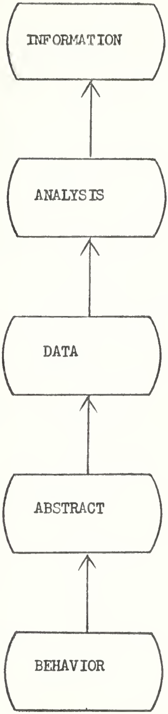

Fig. 1. --Conceptual Model of an Information System

human need; or it can be the needs which evolve from the common characteristics and process of an organization, such as goals, structure, influence processes, etc. Other constructs and concepts describe the abilities that are necessary to perform the processes which comprise an information system. For example, intelligence is the capacity of an individual to apprehend facts and their relations, and to produce information. The military defines intelligence as information which is communicated. The processes which provide military intelligence are similar to the processes previously described to produce information, and can be related as follows:

Direction:	Determination of information requirement (stimuli for perceptual process).
Collection:	Systematic procurement and selection ... (Abstract).
Processing:	The step whereby information becomes intelligence through analysis, evaluation, integration and interpretation. (Data, analysis, information).[21]

A necessary final step in the military intelligence cycle is dissemination, which involves the conveyance of information in suitable form (oral, graphic, etc.) to the source with the need. This final step can be correlated to communicative acts which may or may not convey information.[22] The process of conveying meaning among individuals is implicit in the association of an information system with an organization; but the capacity of the organization to apprehend facts must be comparable to its capacity to determine their relationship, in order to produce or communicate information.

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[21]U.S., Department of Defense, Dictionary of United States Military Terms

[22]Steiner, Top Management Planning, p. 476

The automation of information processes began about 1942, and the current information technology is based on both theory and on physical advances of electronics and other sciences.[23] In addition to the voluminous flow of empirical data that has been generated by automation, it has become increasingly apparent that there are still many aspects of reality which technology has been unable to provide satisfactory abstracts, data (descriptive), or analysis.[24] The respective processes for some information systems cannot be identified, but their impact is evidenced by a cumulative effect. Information may result from the subconscious processing of knowledge which was previously stored, and is recalled as data to be related to facts which exist in the immediate situation. Experience, instinct, and other indications of complex information systems must be considered in planning an information system for a formal organization.[25] Adequate information for a decision is related to a compilation of the total abstracts, data, and analysis processed by an individual in a specific situation; there is also considerable evidence, which indicates that the quality of decisions varies in direct proportion to the quality and quantity of information.[26]

John Dearden has dichotomized various types of information into five groups which provide a perspective for information systems. Each of the groups can be considered as a product of the processes described

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[23]John Diebold, Annals of the American Academy of Political and Social Science (March, 1962), pp. 39-45

[24]J.W. Konvalinka and H.G. Trentin, "Management Information Systems," Management Services (September-October, 1965), pp. 27-39

[25]Ibid.

[26]Ibid.

by figure 1, and all of the groups are applicable to the planning and control of the material logistic system.

- Action vs. Non-Action: Action information requires a response by the recipient. Non-action information may advise that an action has taken place.
- Recurring vs. Non-Recurring: Information which is generated at regular intervals and one time reports required for a particular decision.
- Documentary vs. Non-Documentary: Preserved in written form and oral communications or observations.
- Internal vs. External: Internal and external to the respective system.
- Historical vs. Future: Descriptive of past events and anticipated future events.[27]

Each level of decision activity in the material logistic system, individually or collectively, represents a vortex for the dichotomies of information described by Dearden. The totality of processes which establishes the dichotomies of information for an organization, provides the information system for the various levels of decision activity. Communicative acts may be designed to convey information between levels of decision activity, and provide a flow of information based on organizational needs. The information flows represent a network which connects each source of information with the requirement for information in order to satisfy the needs of the organization.[28]

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[27]John Dearden, Computers in Business Management (Homewood, Ill.: Dow Jones-Irwin, Inc., 1966), pp. 115-117

[28]Thomas R. Prince, Information Systems for Management Planning and Control (Homewood, Ill.: Richard D. Irwin, Inc., 1966), p. 19

Decision

Data is necessary to influence individual behavior in an organization, data must be analyzed to provide a meaningful representation of perceptual reality; the result of this analysis is information which is a prerequisite to establish a state of certainty about a specific situation. The processes that comprise an information system are supportive functions for the decision process which is generally manifested by a selection among alternatives.

A decision may be simple and directly or indirectly describe an observable phenomena; or it can be complex and describe an abstract and complex characteristic which is not directly observable. The generic concept of decision is settlement, fixed intention, bringing to a conclusive result, judgement, and resolution.[29] In automatic data processing terminology a decision is defined as the computer operation of determining if a certain relationship exists, and taking the alternative courses of action.[30] This type of decision can be described as an analytic decision, and is the result of identifiable processes to produce information. Decisions that are made by individuals may be analytic decisions; or they may be described as synthetic decisions resulting from complex processes to produce information which include abstracts, data, or analysis that are not directly observable.[31]

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[29]Steiner, Top Management Planning, p. 321

[30]U.S., Executive Office of the President, Bureau of the Budget, Automatic Data Processing Glossary

[31]Konvalinka and Trentin, "Management Information Systems"

Chester Barnard has developed an abstract description of the individual decision process which is related to his concept of the informal organization. Barnard describes the observable decision by an individual as the manifestation of a progression of rational-economic selections which are also influenced by numerous selections that result from unconscious and automatic responses.[32] The synthetic decision can be an incremental choice of one among several alternatives and may be the result of a deliberate selection or of an unconscious and automatic response. The application of this concept to formal organizations does contradict a basic assumption for the classicist's principles of management, which suggests that individuals in organizations select alternatives on a rational-economic basis, and that this characteristic can provide a communicative link for the flow of information.

The selection of alternatives by individuals in an organization extends beyond rational considerations and may or may not have an economic basis. A rational decision is one which effectively and efficiently assures the achievement of aims for which the means are selected.[33] Many writings have determined that each decision in the business organization is the result of a lengthy, complex and intricate process of problem discovery, exploration of methods to solve the problem, and an analysis of the means for solution.[34] Wilson and Alexis provide two general types of frameworks for decision concepts.

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[32] Barnard, "Concepts of Organization"

[33] Steiner, Top Management Planning, p. 328

[34] Ibid.

material logistic information system envisions a structured information flow throughout the material logistic system. This structure would include procedures, equipment, information, methods for analysis, and the people who use the information. The determination of all of the interrelated elements for information flows in the complete material logistic system can be facilitated by the development of a theoretical model for the information requirements which are necessary for the survival of the system. A theoretical model of the decision-making process would enable significant data sources to be related to information which was necessary for planning and control at various levels of decision activity. Data sources which were common to multiple information requirements could be identified, and communication processes designed to convey similar meaning from common data sources to multiple levels of decision activity. This does not imply that the resultant decisions would necessarily represent a more rational response to the information flows, but it does suggest a more common basis for the decisions which are necessary for the survival of the material logistic system.

A generally accepted descriptive theoretical model for the entire decision-making process has not been developed for an organization of any size.[38] This is one of the implicit tasks which has been assigned to the NAVLIS project to be accomplished for the Naval Material Logistic System. The development of the required model is dependent upon an acceptable categorization of the types of decisions which must be made by individuals in the organization, and the establishment of a relationship between the categories of information and the types

[38]Steiner, Top Management Planning, p. 325

of decisions. A complete decision model should reflect all dimensions of choice situations. There are numerous criteria for grouping decisions in terms of the requirement for information.[39] Classification criteria include determinative and interpretive; planning and control; organizational levels; various time criteria such as frequency or urgency; anticipated impact on the total system. George Steiner provides several additional criteria that are also applicable, these are:

- Broad-Comprehensive and Tactical-Operational
- Organizational and Personal
- Programmed and Non-Programmed
- Certainty and Uncertainty
- Problem Solving[40]

Regardless of the particular criteria selected to identify the levels of decision activity in the material logistic system, it will be necessary to provide sufficient flexibility for creativity and imagination to be reflected in the decision-making process. The criteria should recognize the impact of the human information system on the empirical structure of information flows, and acknowledge that decision-making is an incremental and sequential process.[41] Figure 2 is a conceptual model of one perspective for levels of decision activity, and aligns the relationships based on the organizational hierarchy of the Naval Material Command. The determinative and interpretive levels of decision activity include open and closed models of decisions, and each level may be stratified based on any of the previously described criteria.

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[39]Ibid, pp. 325-327

[40]Ibid, pp. 325-327

[41]Ibid, p. 326

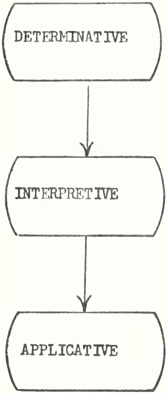

Fig. 2. --Conceptual Model for
Levels of Decision Activity

Conceptual Model

The traditional concept of the flow of authority and influence envisions a vertical flow from top management, through middle management to the operating level of the organization. The management structure is perceived as a hierarchial ladder with the higher order goals established by a determinative level of decision activity and communicated to the applicative level of the organization by various strategies based on the predominate management philosophy in the respective organization. The classicists principles of management are influenced by assumptions that individual behavior is determined primarily by economic factors; and that rational-economic selection of alternatives is a common behavioral characteristic of individuals in an organization.

Goals, structure, communication process, and decision process are common characteristics and processes of every organization.[42] These characteristics and processes are interrelated and interdependent, and coordinating techniques are required to ensure that the relationships are mutually supportive. A hierarchial structure of authority may be established with a group, generally described as middle managers, to act as an interpretative agent and facilitate the communication process. The staff technique can also be utilized to bridge management gaps, or to compensate for either recurring or non-recurring overloads which impact on other organizational processes. Regardless of the coordinating technique, the information system must enable the development of sufficient information to effect the desired behavior of each individual in the organization.

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[42]Likert, New Patterns of Management, p. 178

The information system is envisioned by NAVLIS as being parallel to the organization structure. Figure 3 is a conceptual model of the relationship between needs for information, an information system, and the reactions which may be caused by the communication or acquisition of information. The reaction to information is subdivided to reflect the various levels of activity which could exist in an organization. Determinative, interpretive, and applicative levels of activity are arranged on the basis of a hierarchial structure; however, this sequence is not necessarily restrictive, e.g., determinative and interpretive levels could be concurrent processes. The two models for needs may be identical for an individual. For an organization, these models may reflect the potential variation between needs at levels of decision activity, and needs at the applicative levels of activity. The assumption is made that goals are manifestations of individual and organizational needs. However, when the acts of two or more individuals are systematically coordinated to establish an organization, need/goal congruency becomes an important consideration.[43]

Research findings, from studies in human behavior, have determined that the goals which are determined by the executive level of management are not as easily communicated to the operating levels as initially assumed based on various concepts of a rational-economic man. Information must be received as well as transmitted in order to be communicated, and economic factors may not be sufficient to ensure that the receiver is participating in the communication process.[44] Some management strategies, such as participative management, have

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[43]Barnard, "Concepts of Organization"

[44]Steiner, Top Management Planning, p. 402

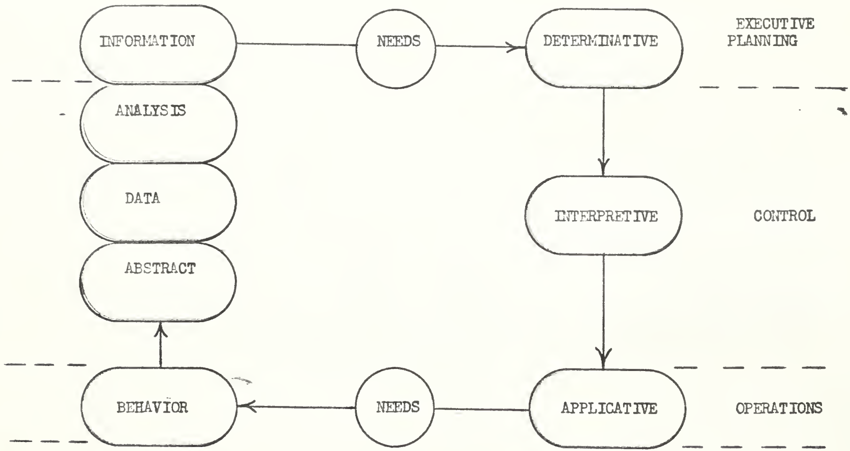

Fig. 3. -- Conceptual Model of Information System
in Support of Decision Activity

restructured the communication process to improve the transmission and receipt of information. Other management strategies have retained the traditional structures and incorporated revised techniques such as results oriented management. Most current strategies, however, reflect an increasing dependence upon computer technology and attempt to exploit the potential advantages of automation in the design and development of an information system.

The computer was initially regarded by many managers as a potential replacement for various levels of decision activity; and the eventual obsolescence of middle management continues to be a popular notion among writers in the management field. Computer applications in business were initially designed to accomplish clerical work, and revised many of the functions which are performed by the applicative level in the organization. Automatic Data Processing has increased the capability to abstract and to develop data; the technology has also identified potential information flows which are not supported by the traditional formal organization structure. Figure 4 illustrates the impact of abstracts and data, provided by mechanized processing, on the conceptual relationship between an organization and its information system. Computer systems application during 1950-1965 did not significantly change the planning or control processes in organization.[45] These applications did, however, initiate trends which are gradually changing the functions performed by managers.

Information technology emerged as a discipline which was equally applicable to the business process about 1962. Because of volume,

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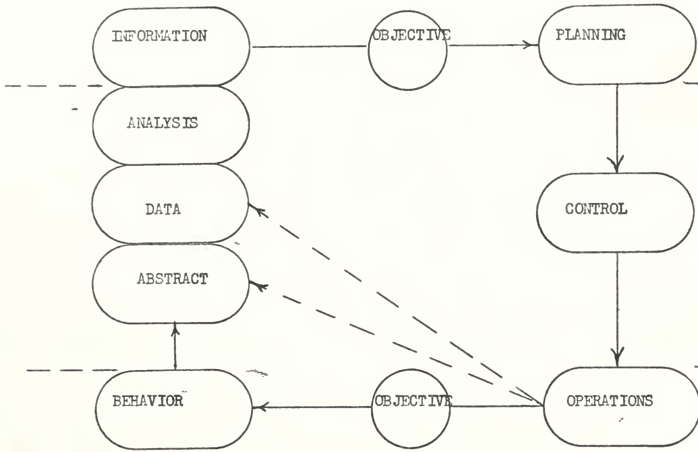
[45]John Diebold, "The Changing Role of the Computer", Harvard Business Review, January-February, 1969



<u>COMPUTER SYSTEMS APPLICATION</u>
<u>(1950 - 1965)</u>

- Accounting ledgers
- Personnel payroll
- Inventory level
- Production output reports
- Distribution reports

Fig. 4. -- Impact of ADP on Information System (1950-1965)

management reports and listings, which during the pre-computer era were considered as information, were reduced in status to data. The applications for the computer during the 1950-1965 period focused management attention on the need to analyze data in order to obtain information which could be used in the management processes. The 1965-1968 era of automatic data processing reflects the initial attempts by management to structure the potential information flows which became evident during the 1950-1965 period. Management has recognized the need for the analytic processes, and is attempting to convert the mass of data and abstracts generated by automation into useful information which can be utilized for the planning and control functions.[46] Figure 5 illustrates the management applications which have been effected through 1968 and their impact on the conceptual model.[47] Efforts to structure the potential information flows has resulted in a significant increase in information for management; however, the benefits of this information have been largely restricted to the lower levels of middle management or supervisory control functions. The routine decision-making activity of middle managers is being increasingly integrated into a normal cycle of business processes. The role of the middle manager, however, is not being reduced but is being expanded; freedom from routine decision activity will enable the middle manager to do more creative, imaginative work.[48] The influence of automation has not as yet reflected the benefits for levels of management

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[46]Ibid.

[47]Ibid.

[48]Steiner, Top Management Planning, p. 510

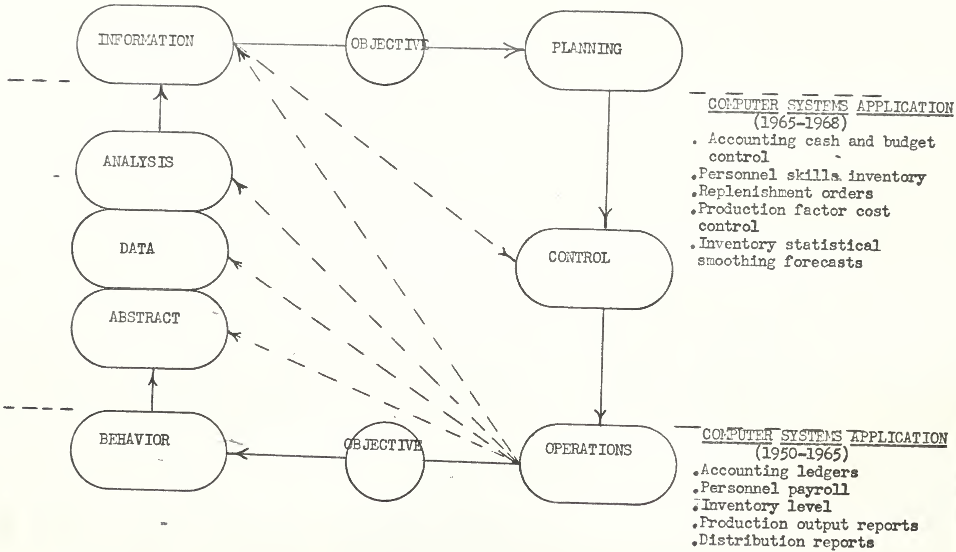

Fig. 5. -- Impact of ADP on Information System (1965-1968)

above the supervisory level; however, the influence can be expected to rise up the management hierarchy.[49] In order for the benefits of automation to be reflected throughout the control level of decision activity and also impact on the planning level of decision activity, a structure is required which will equate the organizational capability to analyze data with the current technological capability to abstract and identify facts about the activity of the organization. Management of computers is currently a major problem; however, this problem relates to the role of computers in the organization, as well as administrative control for computer procurement and utilization.

One of the system design precepts of the NAVLIS project is micro-input. This precept envisions the entry of the data into the material logistic system in its smallest elements, at one time and one place. Additional precepts include multiple use of single inputs; data aggregation, with multi-level access to enable data availability to various decision levels; vertical search; adaptive capability; and inter/intra service compatibility. These precepts will be discussed later; however, they are significant in relation to the development of a conceptual model. The eight precepts of the NAVLIS project are summarized and illustrated by figure 6; the NAVLIS module is intended to supplement the processes which have been identified as an information system. The model identifies a sequence of activities which provides a framework for various organizational functions. Perceptual feedback and other observable phenomena of the human information system are incorporated and indicated by the various closed loops. This concept envisions

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[49]Ibid, p. 513

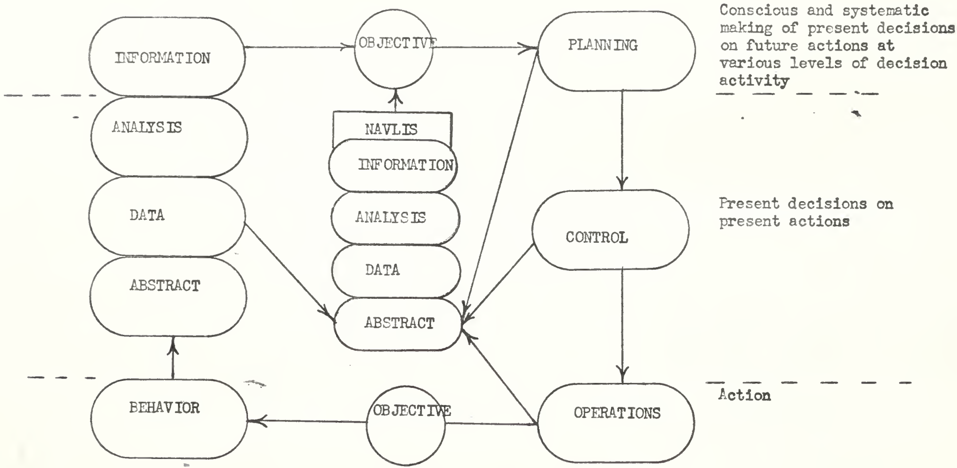

Fig. 6. -- Conceptual Model for NAVLIS and
Levels of Decision Activity

a dual information system for each level of decision activity in an organization. Figure 7 illustrates the relationship of NAVLIS to multiple levels of decision activity.

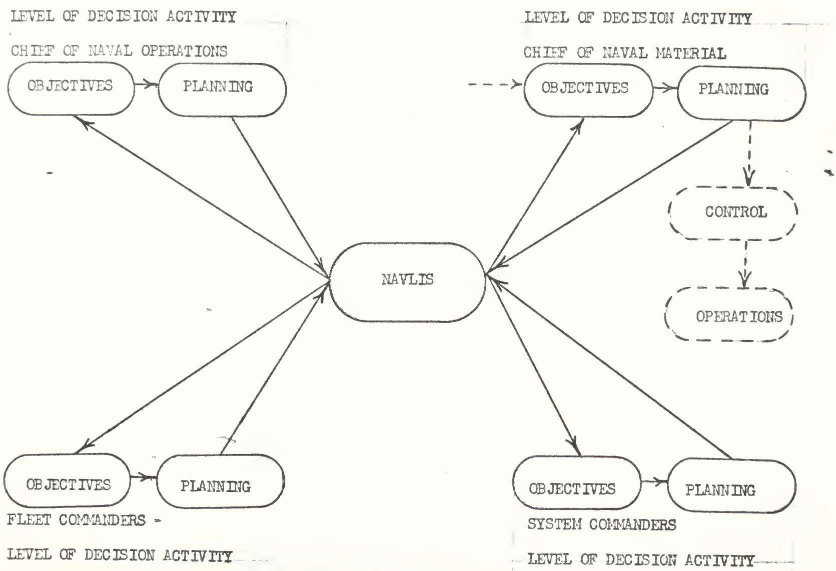

Fig. 7. -- Conceptual Model of NAVLIS and Organization Hierarchy

CHAPTER IV

A RESTRUCTURED SYSTEM

The Material Logistic Information System

There is very little agreement on just what a material logistic information system is, in fact several authors have observed that this is one of the major problems with a Logistic Information System. No single, generally accepted definition for management information systems has been established, in spite of the volumes which have been written about them.[1] The phrase Management Information Systems is widely used throughout government and industry, but there is still a lack of consensus on what management information systems are supposed to be.[2] Additional confusion is generated by the synonymous use of "total systems," "integrated information system," "total information systems," and "management information systems."[3] All of these phrases have been used to describe the mission of the NAVLIS project.

There is, however, a common intent, implicit in each of the phrases which does reflect the objectives of a Navy Material Logistic

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[1] George J. Berkwitt, "Systems: Too Much Too Soon," Dun's Review, June, 1968, p. 40

[2] Robert Beyer, "A Positive Look at Management Information Systems," Financial Executive, June, 1968

[3] Steiner, Top Management Planning, p. 505

Information System. The purpose of managing information is to influence the behavior of the individuals who plan, control, and operate the material logistic system. The objective of NAVLIS is the development of a network for information flows, which will orient individual behavior toward the goals of the material logistic system. Individuals and objects in the network will be united according to an integrated scheme, in order to provide each level of management with information that affects goal oriented decision activity.[4] The total complex of processes which produce and communicate such information is the material logistic information system.[5]

The NAVLIS project is a research and development effort which is predicated on the assumption that the current information systems for management of the material logistic system can be integrated, both internally and also with other information systems such as personnel, operations readiness, and aviation. The concept of an information system, the processes of abstraction, data, and analysis, suggests that the complete coordination of all information systems will require a structure which connects each source of data to a requirement for information.

The formal organization for the material logistic system does not provide a complete reflection of the data sources or the requirements for information. Every functional interface within the material logistic system can be considered as a data source; these interfaces are not

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[4]Ibid, p. 505

[5]Marshall K. Evans and Lou R. Hague, "Master Plan for Information Systems," Harvard Business Review, January-February, 1962

necessarily related to the objectives of the organization, nor are the interfaces controlled by any particular function.[6] Additionally, the material logistic system has not been organized to provide the best means to communicate.[7] The current organization for the material logistic system is a necessary foundation for the development of a material logistic information system; however, each characteristic of the organization such as goals and objectives, problem solving processes, decision-making processes, influence processes, and communication processes, must also be structured in order to develop an integrated information system.[8]

Unique principles for the system design of a Navy logistic information system have been established. The first principle of micro-input, envisions the entry of data into the system in its smallest elements at one place and at one time. This principle would provide a common data source for multiple information requirements, and also simplify the abstraction and identification processes for development of management information. Large scale application of the micro-input precept would enable each operational unit to provide initial abstracts based on empirical behavior. Intermediate decision activity also represents micro-inputs, and would supplement the data provided by the applicative level of activity, to produce information for successively higher levels of decision activity.

Standard codes and symbols facilitate the identification of abstracts and minimize duplication of micro-inputs. The Defense

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[6]U.S., Department of the Navy, MERI Study, p. 69

[7]Ibid.

[8]Likert, New Patterns of Management, p. 178

Logistic Service Center (DLSC) at Battle Creek, Michigan, has experienced considerable success in the development and maintenance of a single uniform material identification system. This system maintains over 8 million manufacturers' part, drawing, and reference numbers; and approximately 4.5 million Federal Stock Numbers which have been assigned to government items of supply. The DLSC total in and out communications is approximately 10 million characters daily.[9] Although an estimate of the aggregate of abstracts for a material logistic information is not available, DLSC operations do provide an indication of the technological possibilities and also reflect the current trends toward standardization and centralization. Current ADP efforts by the Navy Department are oriented toward centralized analysis and programming; the development of a Navy standard COBOL, standardized file structure, common data elements and codes, and other efforts are in progress, and could eliminate many of the administrative impediments to complete centralization. For example, officials in the Navy estimate that within two years COBOL will be a requirement for all Navy programming. Most of the current major operational programs are still programmed in proprietary languages unique to the hardware manufacturer and present major communication and conversion problems.

Additional principles of the NAVLIS system design include integrated data banks, multiple use of single inputs, data aggregation, and multi-level access for the use of micro-inputs by various levels of decision activity. One observation which has been made regarding the operational concepts of NAVLIS indicates that everyone is in favor of consolidating data into as few data banks as possible, as long as its

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[9] C. R. Niemann, "ADP Support of Government Logistics Services," Datamation, February, 1969, p. 73

someone else's data. This observation reflects a dichotomy of the current desire to integrate the information systems for the material logistic system. The NAVLIS concept does not necessarily embrace the notion of a single master data bank. One massive data bank may soon be technologically feasible; however, because of the varied and unpredictable nature of data requirements, the concept of a single gigantic data bank may still be little more than a dream.[10] Alternate concepts such as multiple data banks, which are linked through a system of equipment, communications, languages, and procedures will also be investigated by the NAVLIS project.

Multiple use of single inputs and multi-level access provides a significant potential for work reduction. The NAVLIS work study identified more than 500 independent information systems and each system was dependent upon an unique data base. In 1967 the Naval Material Command identified over 2500 reports, which were provided by automated and manual systems, to assist various levels of management.[11] It can be assumed that the various systems for providing information to managers evolved from the need of individuals for data on which to base decisions.[12] This evolution occurred, however, without an overall conceptual framework to serve as a guide for long range development; and without a management structure in the Navy organization to provide

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[10]Robert N. Anthony, "Planning and Control Systems, A Framework for Analysis" (Graduate School of Business Administration Harvard University, 1965), p. 45

[11]Rudden, "Lifeblood of Management"

[12]U.S., Department of the Navy, NAICOMIS Report, p. 53

a focal point at each level for managing the automatic data processing systems effort during the evolution.[13] Inadequate planning and other problems during the evolutionary stage have resulted in the development of many duplicate information systems, the identification of similar items by different codes, and the absence of an inventory of the various applications of ADP equipment for current information requirements.[14] A NAVLIS structure that related single inputs to multiple information requirements would identify existing duplicative efforts, and control future proliferation which might be caused by new requirements for information. The concept of a common data source with coordinating links to all levels of management also presents problems of a major magnitude for managers.

The conceptual model (Figure 6) identifies the levels of decision activity by the traditional terms of planning and control. This distinction is made to indicate that some classification for management decisions can be effected within the organizational hierarchy of the material logistic system. The total system concept of NAVLIS presumes that an acceptable classification for decision activity can be determined and that data can be aggregated in accordance with the information requirements at the respective levels of activity. A common data source with multi-level access would enable each level of decision activity to evaluate the decisions which were made by subordinate levels, and also enable subordinate levels to critically evaluate decisions which were made by higher levels. The availability

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[13]Barker, "Achieving Overall ADP Systems Compatibility"

[14]Ibid.

of a common data source cannot presuppose that the subsequent analysis will produce common information, nor can the assumption be made that every manager will agree on the rationality of decisions which are produced by a similar information system. In the environment which would be created by the precepts of NAVLIS, the intangibles of a synthetic decision would appear to be the only deterent to a rational-decision. These intangibles could easily be regarded as impediments to flows of information between the highest levels of decision activity and the operating level, and accelerate the current trend toward centralization by gradually escalating the decisions to successively higher levels. The material logistic system is not totally observable, and even the complete realization of the NAVLIS objectives would fall short of a full reflection of the total system.[15] Each level of decision activity responds to some manifestation of the observable aspects of the material logistic system; this response would be affected by information produced by the material logistic information system, but it would also represent abstracts, data, and analysis which were unique to the information system of the particular manager. If the intangibles of a synthetic decision by a manager are eliminated, a major data source which would have been provided to the next level of decision activity is also eliminated. Many aspects of the material logistic system such as mental attitude of personnel, motivation of individuals, health of key personnel, software reliability, and others can only be reflected by the decisions which are made at the data source. Various levels of decision activity are necessary to provide flexibility in order to cope with the varied and unpredictable nature of information

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[15] Prince, Information Systems for Management Planning and Control, pp. 15-16

requirements for management. Even this provision for flexibility may not be sufficient, there is considerable doubt by several management authorities that the extreme variation and unpredictable nature of data will prevent the effective design of a total information system such as NAVLIS.[16]

The operational concept of NAVLIS is based on precepts which suggest a single all encompassing network that will provide for all information requirements in the Navy Material Logistic System. Some managers regard the NAVLIS as more of a philosophy than an operational concept, and suggest the reasonable relationship of major and minor systems as a more practical approach.[17] The idea of a reasonable relationship between major and minor systems is illustrated by a description of the requirements for a material logistic information system. These requirements include the following:

- Provide each executive information needed for: Identifying and choosing among alternative courses of action, planning the end results for which he is responsible and the specific actions to achieve these end results ...
- Concentrate on developing information rather than facts. It should provide the relevant and omit the irrelevant data.
- Conform to and reflect the organizational structure and delegations of authority.
- Integrate the information at all levels into a consistent body of data and in such a fashion that reports become more condensed the higher the level of management.

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[16]Anthony, "Planning and Control Systems," p. 45

[17]Steiner, <u>Top Management Planning</u>, p. 506

. Recognize the difference between information requirements for planning and requirements for control.

. Develop timely data which covers financial as well as non-financial information requirements.

. Utilize common data to the fullest extent possible, relevant parts of different individual information systems should be related and be comparable.

. Recognize that for most information systems used by a manager, particularly higher level managers, human communication is indispensable to understanding.

. Emphasize and amply cover information about operational elements and environmental forces which are most responsible for success or failure.

. Reflect the participation by management in the development of the system.

. Relate the flows and collections of information to the management style of managers.

. Provide predetermined guides for printed reports.

. Utilize computers in the most appropriate manner.[18]

These objectives are incorporated in the NAVLIS concept; however, some criticism of NAVLIS implies that the project represents the establishment of a relationship between information requirements for executive planning, and data generated by operations on the basis of logical reasoning, rather than observable facts. Although the problems which confront managers in the current material logistic system are factual, the NAVLIS project may not be able to convert an ideal solution into

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[18]Ibid.

real relationships which are sufficient to resolve the existing problems. Regardless of the measurable success of the NAVLIS project, it will establish a trend by promoting the significance of at least two critical requirements of the material logistic system. These requirements are the need for a material management plan and more effective control for existing automatic data collection systems.

Material Management Plan

The focus of the NAVLIS operational concept is on the information requirements for various levels of decision activity, throughout the Department of the Navy, in relation to the material logistic system. NAVLIS is the first attempt within the Navy to view the material logistic system as a comprehensive, integrated whole. The Department of the Navy Management Information and Control System (DONMICS) will provide the frame of reference for the NAVLIS project. The primary objectives of DONMICS are:

- The orderly and timely collection, maintenance and dissemination of information tailored to the decision requirements of the various management levels ...
- The generation of data at all organizational levels which is properly structured, related and aggregated to satisfy the needs of successively higher and lower levels of the management chain ...
- The flexible adoption to changing management information requirements.

. The achievement of optimal economics in operating the system at a desired level of effectiveness.[19]

One of the basic steps in the establishment of an information system of any size, and which is necessary to achieve the objectives of DONMICS, is the establishment of long range objectives for the environment in which DONMICS and NAVLIS will operate.[20] It was determined in 1965 that there was no officially promulgated document which represented a material management plan for the Department of Defense.[21] A comprehensive study, initiated by the Office of the Secretary of Defense in 1962, resulted in a study report called the Responsive Automated Material Management System - 1968. This study report was not officially implemented; however, it was instrumental in setting various trends toward more centralized management.[22] The RAMMS' study report has been called the unofficial plan guiding OSD's actions, and many of the military standardization programs reflect the recommendations of the RAMMS' study.[23] Recent investigations and studies have supported the RAMMS' study and emphasized the need for more centralized direction and guidance in the development of logistic systems. A review of major logistic systems was conducted by the Assistant Secretary of Defense for Installations and Logistics in September of 1968. As a result of

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[19] Richard E. Barry, "Donmics - Toward a Network of Department of the Navy Information Systems," Navy Management Review, September, 1968, p. 5

[20] Evans and Hague, "Master Plan for Information Systems"

[21] Robert A. Wells, "RAMMS Revisited: A Current Look at the Continuing Need for A DOD Materiel Management System Blue-Print," (Industrial College of the Armed Forces, 1964-65), p. 3

[22] Ibid, p. 74

[23] Ibid, p. 74

this review a joint staff was established, with representatives from each of the services, to begin the examination of objectives and accomplishments of common logistic systems. The joint staff was tasked with the development of proposals for a set of specific objectives to guide the development of a long range blueprint, which would be presented to the Material Secretary of the Navy and the other services in 1969.[24] The initial review of logistic systems in September 1968 is considered to be the information base for the blueprint development, and services have been requested to provide the DOD joint staff with copies of all major changes to existing logistic systems and logistic organizations. Specific review points have been identified by ASD(I&L) regarding development of Navy logistic systems, and the current plan is to conduct the reviews on an informatl basis.[25]

The design of a blueprint for logistic systems at the DOD level can provide the necessary long range objectives for the NAVLIS project; however, the development of this blueprint is dependent upon several significant assumptions, which also impact upon the efforts the Navy material logistic information system project. The blueprint effort assumes that specific objectives which are common to each service and to the Department of Defense, can be identified, documented and agreed upon by the primary parties concerned. The ability to structure information requirements for the Navy material logistic system presupposes that a hierarchy of objectives exists, which will provide a framework

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[24]Memorandum from Assistant Secretary of Defense to the Assistant Secretaries of the Army, Navy and Air Force (Installations and Logistics) and to the Director, Defense Supply Agency, dated October 8, 1968

[25]Memorandum from the Assistant Secretary of Defense to the Assistant Secretaries of the Army, Navy and Air Force (Installations and Logistics) and to the Director, Defense Supply Agency, dated Feb. 14, 1969

for an integrated information system. If these objectives cannot be identified from the top down, the success of any effort by the NAVLIS project to predetermine the levels of decision activity would be questionable. The blueprint design effort also implicitly assumes that there is a commonality among the various functions which must be performed for an effective and efficient logistic system. Functions that are currently being performed intra-service, such as inventory management logically should be sufficiently similar to enable their correlation to the specific objectives, in order to measure progress toward the objectives which are established. If a definitive relationship cannot be established between the objectives and the efforts required to achieve the objectives, it is doubtful that the necessary requirements for management information could be determined.

The Navy material logistic information system and the DOD blueprint design are both subject to the constraints of the current concept of levels of command as reflected by the current organization, and the basic premise that levels of command and levels of decision activity are synonomus. The success of functional team concepts such as the project manager, indicate that traditional organizational precepts may be inadequate to identify the levels of decision activity within an organization. The assumptions which are applicable to the DOD blueprint effort will also be determinants of the NAVLIS project success.

The development of the information systems that currently exist for the material logistic system has been dependent upon mission statements which are designed for specific activities. The absence of an official material management plan for the Department of Defense may

indicate a major deficiency in the transition from purpose to mission statements within the Navy material logistic system. This deficiency is further indicated by the significant degree of dissimilarity among the information systems. The investigation of existing systems by the NAVLIS project can provide a point of departure for NAVLIS development; however, this approach may tend to focus on the similarities of existing systems without sufficient emphasis on the dissimilarities of information requirements and mission statements. The proposed technical approach for NAVLIS does not include the alternative of a complete reevaluation of information requirements based on objectives for the most efficient and effective material logistic system. The NAVLIS approach is designed to develop a system of systems, and accepts the constraints of organizational objectives which have already been established. Mission statements do identify goals for respective activities, but unless the mission statements are interrelated and interdependent they may not provide a valid reflection of requirements for information relative to the establishment of a totally integrated information system.

A material management plan is an important part of the foundation for the development of a totally integrated material logistic information system. In order to support the objectives of DONMICS, the plan should reflect the needs of all systems with which NAVLIS will interface. The plan could then provide a frame of reference for the investigation of information requirements of the various functions and organizational elements within the material logistic system. The Department of Defense is in the process of developing a long range material management systems blueprint; this blueprint can provide the necessary frame of

reference for NAVLIS, it could also provide a communicative vehicle for the NAVLIS interface with the logistic system. NAVLIS is a total material logistic information system, and is a component of the total logistic system.[26] The existing systems will be used as a basis for NAVLIS, and the investigation of these systems is a necessary step to improve the processing for information; however, this step could be preceded by the determination of specific objectives for the material logistic system. The development of a plan such as the DOD blueprint could be followed by the design of an information system which would identify the desired information requirements.

Investigation of Current Systems

The analysis of existing information systems will be facilitated by several major efforts which are now in process. One major effort is oriented toward Automatic Data Processing (ADP) Systems and Applications. The ADP system is a term which describes the interacting assembly of procedures, processes, methods, personnel, and automatic data processing equipments to perform a complex series of data processing operations.[27] The Office of Information Systems Planning and Development (OISPD) is preparing an ADP management division reports inventory of ADP systems and applications. OISPD has developed a list of information requirements for ADP systems and applications, which is subdivided into sections based on identification of systems and applications, quality of various systems, and accessibility of data bases.

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[26] U.S., Department of the Navy, Chief of Naval Material, Instruction 5430.38

[27] U.S., Executive Office of the President, Bureau of the Budget Automatic Data Processing Glossary

The identification of an ADP system will be based on the most critical characteristic of the system which is data flow.[28] The term application refers to the system or problem to which a computer is applied; parameters for ADP systems will be established by the identification of a series of ADP operations, tied together by data flow, and devoted to some set of functional problems.[29] The quality of the system will be determined based on redundancy between systems and applications, utilization of common languages such as "COBOL", "FORTAN" or "JOVIAL", and degree of fractionation of processing cycles.[30] The data base accessibility will be identified by factors such as location, content and format, security classification, and media of availability. All data processing installations in the Department of the Navy will be requested to provide a brief description of each application and some basic application information, which will include the data on which the application became operational, the number of computer programs, type of equipment, and the type of application such as business and logistics or scientific and engineering. Installations will also be requested to provide descriptions of the files used in the application; all master files which maintain the data base will be reported, and some selected working files will also be reported. Standard manuals which provide highly structured code numbers for various functional areas are available, and will be utilized to provide a file description of each data element file.[31] The development of a complete inventory of ADP systems and

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[28] E.L. Snider, "Department of the Navy Special Project Develops Plan for Automatic Data Processing Systems Inventory," Navy Management Review, September, 1968, p. 17

[29] Ibid.

[30] Ibid.

[31] Ibid.

applications will enable OISPD to determine the relationship between various systems and applications and to monitor the flow of data between ADP installations. Subsequent efforts by OISPD will be directed toward the development of sufficient data to correlate resources, systems and applications, and management perspective by installation. The efforts by OISPD will make it possible to quantitatively identify a major portion of the data base for a Navy Logistic Information System, and will impact significantly on the operational concepts of the NAVLIS project. Considerable data has already been collected by OISPD and it is anticipated that a reports inventory will be available for distribution early in calendar year 1969.

The three major material logistic systems in the Navy are the Uniform Automated Data Processing System (UADPS), Maintenance, Material, Management System (3M), and Type Commanders Automated Data System. In 1962, the Naval Supply Depot, Newport, was selected as the pilot activity for the UADPS system; today UADPS is in operation or under development at many activities throughout the Naval Material Command, the UADPS concept includes centralized system design, uniform procedures, rapid communication links, and full utilization of DOD military standard programs. Centralized direction for UADPS is provided by the Naval Supply Systems Command, through the Fleet Material Support Office, to the inventory control points, material stock points and various fleet units. UADPS is operational at three inventory control points, Aviation Supply Office, Electronics Supply Office, and the Ships Parts Control Center; and is being used to manage approximately 850,000 line items, 100,000 daily transactions, and an inventory value of about 5.5 billion dollars.

The first Navy stock point was converted to computer operations in 1958 using RAMAC 305 equipment, by December 1968 there were 440 computers in use by the Navy for business and logistics applications.[32] UADPS is being applied for approximately 76 aircraft carriers and tenders to process about 6000 transactions daily. The utilization of computers throughout the logistic system has enabled the daily updating of stock records in 30 minutes, compared to five hours by manual methods; stock reorders that previously required 16 hours can now be accomplished in 25 minutes.[33] The 3M system provides 484 information reports to managers at all levels in the logistic system. Univac U-1500 computers are utilized by nine type commanders to monitor ships performance, manage money and material, and measure ships readiness.

The three major systems illustrate the current scope of computer utilization in the material logistic system, and the enormity of the tasks which confronts NAVLIS. Programming for some system applications has been accomplished using symbolic input data to produce machine instructions (assembly), other applications are programmed in a lanuage designed for problems which can be expressed in algebraic notations (FORTRAN), and still other applications are programmed using a specific language designed for business data processing procedures (COBOL). Most of the major operational systems in the Navy are programmed in assembly programming language that are proprietary languages unique to the hardware manufacturer. The conversion problems which result are illustrated

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[32]U.S., Department of the Navy, Office of Information Systems Planning and Development ADP MIS Summary Activity Report, February, 1969

[33]RADM B. H. Bieri, Jr., SC, USN, Speech before Naval Reserve Supply Officers 9-7, at Chicago, Illinois on November 2, 1967

by the current status of the Navy Inventory Control Points. The Inventory Control Point System contains about three million programming steps, and is programmed in assembly language of a particular manufacturers computer. The computer now in use is scheduled to be the last in its series and the cost of ICP conversion to third generation computer capability is estimated to be as high as twelve million dollars.[34]

In addition to intra-Navy problems resulting from machine independence and inability to communicate between many systems, there is also an increasing need for inter-service compatibility which can only be promoted by an integrated internal Navy information system. The critical need for a material management plan is emphasized by the prospects of attempting to analyze and restructure the existing information systems. An ADP inventory of systems and applications will provide greater visibility of the magnitude of the NAVLIS project, this inventory may also emphasize the philosophical aspects of an all encompassing material logistic information system. Subsequent efforts by OISPD to relate ADP systems, resources and applications will facilitate improvements to the current complex of information flows, but additional structures will also be required if the composite of all information flows in the material logistic system are to be integrated. The systems and application inventory effort is oriented towards automated systems and will focus on the dichotomies of information which are automated. The NAVLIS project is tasked to integrate the total material logistic information system.

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[34]Barker, "Achieving Overall Systems Compatibility," p. 11

Requirement for Information

The scope of NAVLIS extends considerably beyond the parameters of the automated aspects of the material logistic system. Effective and efficient management of ADP systems and applications will enable the analysis of a significant part of the information requirements for the material logistic system; however, there are additional primary information flows which must also be analyzed. These additional flows are implicit for example in the continued use of the term "command" to identify the Navy Integrated Command/Management Information System (NAICOM/MIS) which is the larger component of DONMICS that will incorporate the smaller NAVLIS component.

A command/management information system is defined as the facilities, personnel, procedures, doctrine, equipment and communications processes and distribution systems by which integrated data and information are provided and employed by a commander in decision-making, management, control, direction, and/or support of naval forces and commands.[35] This definition could be restated as the totality of information flows which are necessary to enable a commander to make a rational decision. The term "rational decision" is used here in a traditional sense, to reflect a norm which holds that the selection of the most desirable alternative requires the comprehensive and simultaneous examination of ends and means.[36]

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[35]U.S., Department of the Navy, NAICOMMIS Report, p. 57

[36]Aaron Wildansky, The Politics of the Budgetary Process (Boston: Little, Brewer and Company, 1964), p. 150

Management information systems are genetically related to automated data processing; command is the authority vested in an individual to direct, coordinate, and control military forces.[37] (Italics my own). The data source for a command and control system is frequently identical to the data source which would be utilized in a management information system. The term command emphasizes the analysis process, and the significance of the information systems which support the open decision model as well as quantifiable data and analytic decisions which might be provided by mechanical processes. This emphasis is frequently absent in private industry and the role of the individual in management information systems is sometimes a neglected fact.[38]

There are certain processes and objectives which are common to all information systems regardless of scope or complexity.[39] The decisions which are necessary to plan and control, provide a focal point for analysis of the information flows in any organization; this approach is equally applicable for a command/management, management, or a command and control information system.[40] A systems approach based on decision activity can be simplified by grouping the types of decisions which must be made; and although there is no generally agreed upon basis, some form of functional or organizational related grouping

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[37]U.S., Department of Defense, Dictionary of United States Military Terms for Joint Usage, p. 49

[38]W.M.A. Brooker, "The Total Systems Myth," Systems and Procedures Journal, July-August, 1965, pp. 28-32

[39]Head, "Bytes and Pieces"

[40]Prince, Information Systems for Management Planning and Control, p. 19

would facilitate both the analysis of existing flows and the design of a new structure. One criteria which could be used concerns the characteristics of the decision as described by the general area that the decision concerns, the time dimensions of the decision process, and similarity of requirements for information.[41] Based on the assumption that information is necessary for each management decision; a network of information requirements can be developed for each group of decisions that have common characteristics. This network would connect a group of decisions to a data source, and the total organization would be perceived as a series of large information networks which provided for the flow of information from the sources of data to the requirements for information. Although a major part of the networks would involve machine processing of data, the networks should also reflect the multiplicity of information that is determined by other than mechanical processes and procedures.

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[41]Ibid, p. 19

CHAPTER V

SYNOPTIC DECISION BASE

NAVLIS Structure

A composite, integrated material logistic information system, which connected the sources of data with their respective requirement for information, could provide the various levels of decision activity in the material logistic system with a common decision base. The precept of micro-input provides the foundation for the decision base as conceived by NAVLIS; other precepts such as data aggregation and vertical search capability, are intended to structure the information flows between the micro-input and the information requirements at successively higher levels of decision activity. The information flows would be synthesized as they progress to higher levels of decision activity to enable greater visibility by the determinative level of decision activity. A common basis for decision activity cannot presume that synoptic choices among alternatives will naturally evolve. For example, each level of decision activity will continue to stratify the decision base in terms of feasibility and desirability; these terms are separable for analytic purposes, but they are intimately related in the selection among alternatives by respective levels of decision activity.[1]

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[1]Herman Kahn and Anthony J. Wiener, The Year 2000, (New York: The MacMillan Company, 1967), p. 397

Mathematical techniques, computer technology, and other advances have enabled the limited structure of some data which influences the determination of desirable alternatives in decision making; however, for the most part this aspect of the decision process is still determined by subtle, difficult to evaluate factors.

Decision activity at each level of the organizational hierarchy represents a data source which may or may not be reflected by the NAVLIS module. Non-action information may advise of a decision which was based on non-documentary information; or action information can be developed from external information that was unique to a lower level of decision activity. The impact of various levels of decision activity will be obvious in the early stages of NAVLIS implementation since many generally acknowledged information flows have not been automated. Conferences, correspondence, telephone calls, video transmissions, and other communicative techniques which include information flows, will initially be external to the NAVLIS module; and the importance of man-to-man interfaces will be recognized as a major determinant of information flows and the resultant decisions. However, as the currently predominate communicative techniques are automated, the significance of unidentified and unstructured information systems such as intuition, may become less obvious to higher levels of decision activity. The functional block diagram in figure 8 reflects an arbitrary subdivision of inputs from the data source to illustrate the continued dependence on lower level decision activity for a complete reflection of the data source. The synthetic data system refers the totality of abstracts from the data source which are not primary candidates for micro-input to the

NAVLIS FUCTIONAL BLOCK DIAGRAM

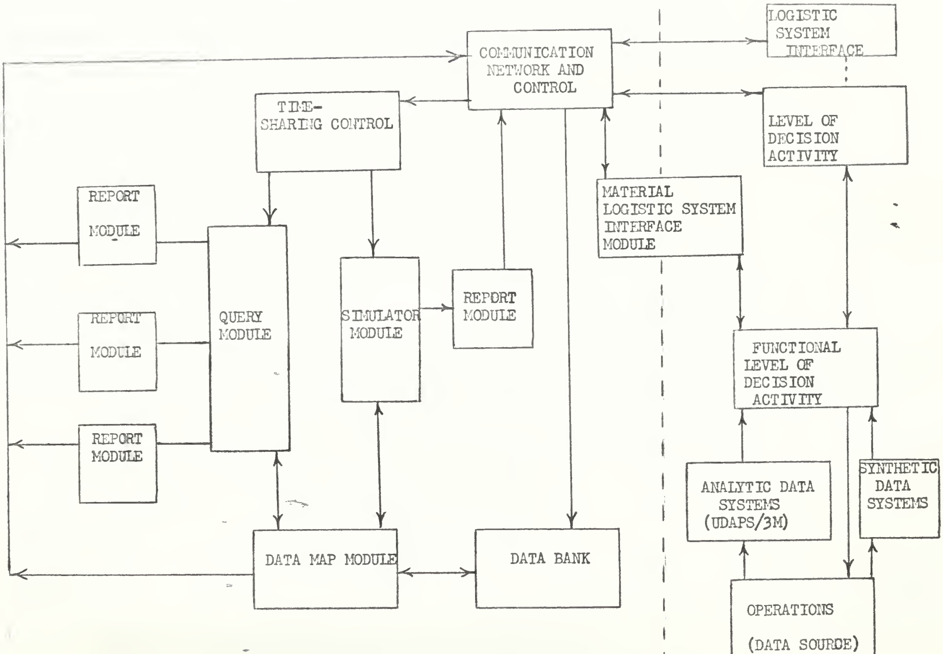

Fig. 8

NAVLIS module. The functional level of decision activity represents the commander/manager at the lowest level of decision activity as a NAVLIS user. Successively higher levels of decision activity within the material logistic system may also be considered as NAVLIS users.

The total number of prospective NAVLIS users has not been determined, however, they can be generally described by two major categories. The first category is indicated by the functional block for logistic system interface in figure 8. The second category is indicated by the functional blocks identified as level of decision activity and functional level of decision activity. The first category indicates users that are primarily associated with other major elements of the logistic system such as weather, personnel, oceanographic, and medical. Data sources and information requirements which are determined to be external to the material logistic system would be provided for in the NAVLIS module by utilizing communication networks that currently exist or can be developed. Communication systems such as the Automatic Digital Network (AUTODIN), telephone, teletype and mail are currently in use. Additional developments such as the IBM 1001 which operates at 12 digits per second over leased lines; the Bolt, Beranek and Neuman, Inc., system which provides two-way communication with a computer using ordinary dial telephones and requiring no additional attachments; and the IBM 2740 which can operate on a party line, are available to augment existing Navy communication capabilities.

Users that are internal to the material logistic system would also be serviced by highspeed input/output terminals which could be connected directly to a computer. Punched card readers and punches can

be connected as remote terminals utilizing voice grade lines and achieve speeds of 100 to 300 characters per second.[2] IBM and Digitronics also offer available systems that can transmit up to 60,000 characters per second, either between two magnetic tape units or between a tape unit and a computer. Existing data systems such as Uniform Automatic Data Processing and the 3M system would retain their identity and would provide a primary source for NAVLIS data. Specific data elements that are required for the NAVLIS system can be determined and standardized in conjunction with NAVLIS module design. Modular systems of NAVLIS can be modified and structural improvements made as these systems are upgraded to utilize higher generation equipments; NAVLIS would provide a frame of reference for revision to existing information systems.

Figure 8 reflects the flow of data for synthetic decisions as a separate channel; however, data that is currently processed via these channels will be increasingly automated, including many abstracts that are currently considered intangible. This point is illustrated by recent developments in holograph; IBM researchers believe that new techniques could lead to practical three dimensional holographic photography within a few years.[3] Machines that can process hundreds of thousands of pictures and rapidly pick out all patterns that conform to certain criteria are currently in use for specific applications; the addition of holograph to highspeed computer operations will have a major impact on the ability to abstract data.[4] NAVLIS is not dependent on the

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[2]U.S., Department of the Navy, Naval Supply Systems Command, "A Fifteen Year Forecast of Information Processing Technology," prepared by George B. Bernstein (Washington, D.C.: January 20, 1969), p. 24

[3]Kahn and Wiener, The Year 2000, p. 103

[4] Ibid, p. 105

technological development of current breakthroughs, but it can provide a sufficiently flexible structure to facilitate the use of new technology as it is developed. The interface module which is required to provide compatibility between internal components and the NAVLIS module can be software, hardware, or a combination of the two.

The NAVLIS module is admittedly very generally described and does not reflect the tremendous complexities involved in the actual design of such a module. The functional components are illustrative of some of the capabilities which should exist in this module, and each component identifies a current practical technological capability. The magnitude of the NAVLIS requirement would be the determining factor for operational capability. The trend is toward systems such as the one illustrated in figure 8, and scope and complexity are rapidly being overcome as restrictive factors. In 1966, Mr. Lipetz advised of this trend and noted the primary limitation at that time. He observed that:

> Fully automated systems have been developed for detecting index codes of various types ... and for retrieving or displaying records on demand ... Records that are clearly in machine-readable form can be transmitted easily over wires and microwave channels to printing devices, recording devices or computers. Records not in machine-readable form can be scanned by optical electric devices and then transmitted to be reconstituted at the receiving end ... Second, the capability of controlling the transmitting process ... can be given to the human or the machine at the receiving end ... With such developments, the geographic boundries of traditional information storage and retrieval systems are beginning to evaporate. In their place are beginning to emerge vast networks of compatible communication devices linking users with many specialized and overlapping collections. Data transmission costs are still sufficiently high, however, to keep the dissolution of traditional systems from becoming a runaway revolutionary process.[5]

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[5]Ben-Ami Lipetz, "Information Storage and Retrieval," Scientific American, September, 1966, p. 238

It is expected that within 15 years the data-transmission cost will be sufficiently low that information storage and retrieval will become the runaway process described by Mr. Lipetz.[6] In order to provide access and response to NAVLIS users, the current technology dictates the need for a time sharing capability. This capability would complement the communications capability and enable economical input to and output from NAVLIS terminals. The time sharing control would interrelate the user terminals to the computer systems, described as the query module and the simulator module, via the communication network. There are several different approaches which can be used, with the proposed time sharing control, the particular approach could be determined by the user capability and vary with categories of users. Some users could be on a conversational mode, with each user allotted a fraction of processing time every several seconds; other users would be restricted to prescheduled periods of uninterrupted processing. The NAVLIS module could operate full-time in the time sharing mode, part-time in this mode and the balance in a batch processing mode, or any combination of the two modes as determined by the input configuration and the number of processors.

The simulator module is incorporated to enable NAVLIS to function as a complete information system. Present decisions regarding future actions may require processing in order to provide additional information. The desired relocation of a fleet unit from the Pacific Fleet to the Atlantic Fleet provides an example of decision activity that can be equated to data; the information which is related to this particular decision can correspondingly be equated to abstracts. It is necessary

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[6] Kahn and Wiener, The Year 2000, p. 96

for the particular level of decision activity to abstract from the total information available, those facts which are considered to relate to the desired relocation, and to perform an analysis based on the relevant data. Additional information is produced which increases the degree of certainty regarding the feasibility and desirability of the decision activity that initially provided the stimulus for the cycle. This cycle can be repeated until sufficient information has been produced to achieve the desired degree of certainty and the initial present decision on future action can be translated to a series of present decisions on present actions. The cycle can be described as a planning process, and the NAVLIS simulator would be utilized to automatically retrieve and assimilate relevant data from the NAVLIS data bank, or from an input source determined by the data map module.

The function of the simulator module presents a major challenge for current technology, particularly in the area of machine programming. The capability based on off-the-shelf items would require a series of specific requests by the user for information that the user determined to be relevant; additionally a special program may be required for each non-recurring query, and data which was not readily available in the data bank would cause significant scheduling and processing problems. The current state of the art does not indicate that an automatic simulator capability would be an economically feasible function of NAVLIS, but the rate of change of the state of the art does support this consideration as a NAVLIS feature.[7]

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[7]Ibid, p. 87

The query module represents the NAVLIS access to data throughout the material logistic system, the capability of processing this data, and the capability to respond to information requirements of NAVLIS users. The operational mode of the query module would be affected by the time sharing control and it could incorporate capabilities such as parallel processing with multiple programs executed concurrently. The query module would include permanently stored programs to satisfy recurring requirements for regular reports. The data map module and the data bank are indicated as separate modules to represent the requirement for internal NAVLIS data, and also a capability to locate and obtain data which is external to the NAVLIS module. Routine information requirements of NAVLIS users would be provided for by the report generator module, this module would also facilitate moving a query off line while additional data, that was required for processing, was being obtained either from the data bank or via the data map module from a NAVLIS component. Factors such as security and query priority can be provided for in the communications module. The executive software package for NAVLIS as represented by the functional block diagram would provide capabilities to accomplish the following functions:

File structure

Query files

Generate reports

Update files

Determine data locations

Stimulate (gaming, regression analysis)

Control user access and NAVLIS response.

The hardware and software capabilities which would be required to implement the NAVLIS module will be determined as the project evolves. The target date for completion of a NAVLIS prototype is 1973, and implementation is planned to occur after 1974. It is difficult to anticipate the revisions which will occur in the state of the art during NAVLIS development; however, current technology and developments indicate that the degree of sophistication implicit in the NAVLIS concept will be a practical reality in the near future. Some of the current technology reflects the tremendous rate of progress that is being experienced:

1. Manufacturing capability of 100-500 integrated electronic circuits on a silicon wafer an inch in diameter and less than one hundredth of an inch thick. Manufacturing of complete communication and computer subsystems containing more than 1,000 circuits each with more than 400 transistors on half a dollar size silicon chips.

2. Burroughs ILLIAC IV computer which will utilize large scale integrated circuits and an extermely highspeed thin film memory and is expected to increase the data processing speed by 500-700 times any existing computer capability. ILLIAC IV is scheduled to be operational by mid-1970.

3. IBM has developed a memory storage system with a capability of storing as many as one hundred million bits of information on a square inch of photographic film.

4. The "Data Device" developed by an Air Force scientist at a cost of $125,000 enables the reduction of data signals to such an extent that an entire library of 20,000 volumes can be stored on an 8 by 10 inch

piece of nickel foil. This device enables one inch of storage space to accommodate the amount of data that would require 10 miles of magnetic tape. Current cost for this device is $50,000.[8]

Examples of existing technological capabilities, expand the frame of reference when considering the NAVLIS project, however, recent projections of probable events almost eliminate the parameters for development of NAVLIS, and illustrate the urgency for the orientation of information systems development in the Navy. A fifteen year forecast of information processing technology which was prepared by the Research and Development Division of the Naval Supply Systems Command advises of technology that is currently available and not being fully utilized, and also identifies projects that are expected to be developed in the near future. Some of the highly feasible and desirable, usable products which are almost certain to be available include the following:

Product	Year of Projected Availability	50% Probability
Techniques for machine reading of general print	1985	1975
Optical page readers to use spelling, grammar and context to check individual characters	1980	1975
Cheaper, smaller and faster circuitry to permit more power at remote terminals tied to central systems	1978	1975
Communication-type processors	1971	1970

[8] Ibid, p. 96

Product	Year of Projected Availability	50% Probability
"Smart" terminals which will permit most of the computing and processing to be done in the communication terminal to minimize communication costs.	1970	1969
Small scale computer time sharing systems.	1973	1971
Plug in jacks for telephone for portable use of digital communication devices.	1975	1972
Cathode ray tube (CRT) displays which operate at electronic speeds (wide spread use).	1972	1969
Standard television sets as input/output terminals (wide spread use).	1975	1972
Page-size, dry process hard copy of CRT output devices.	1973	1971
Graphic input to computers (wide spread use).	1974	1972
Sophisticated man-machine interface consoles with high-speed and high resolution graphic input and output at reasonable costs.	1972	1970
Computer memory cycle at 0.5 micro-seconds.	1969	1968
Mass storage capacities (cost less than a millicent per bit).	1978	1975
Increased use of terminals, mass storage, on line keyboard input, and data capture on line at the source will reduce use of conventional peripheral equipments.	1975	1973

Product	Year of Projected Availability	50% Probability
Indexing schemes will permit retrieval based upon a variety of information characteristics.	1970	1969[9]

The conclusions of the 15-year forecast indicated that the next five years in information processing will not be revolutionary in terms of hardware, but will reflect more efficient use of current equipments. The study discovered that the existing gap between processes to provide information is not caused by the inability to manufacture appropriate hardware, but rather by the inability to utilize and manage the hardware that is currently available. The Naval Supply Systems Command recommended that the following areas be stressed:

- Satisfaction of user requirements.
- Standardization of procedures, equipment, software and data elements.
- Orient the machine capabilities toward the natural human capabilities.
- Adopt new ways of organizing the machine and systems of machines.

NAVLIS as illustrated by the functional block diagram in figure 8 provides a response to the needs indicated by the NAVSUP recommendations.

Advanced Development Schedule

Figure 9 is the current plan for NAVLIS implementation. The proposed technical approach (PTA) was issued on 15 July 1968, and presented a general plan that envisioned NAVLIS as a coordinating module which utilized hardware and software to integrate and structure

[9]Bernstein, "A Fifteen Year Forecast," p. 155

NAVLIS ADVANCED DEVELOPMENT SCHEDULE

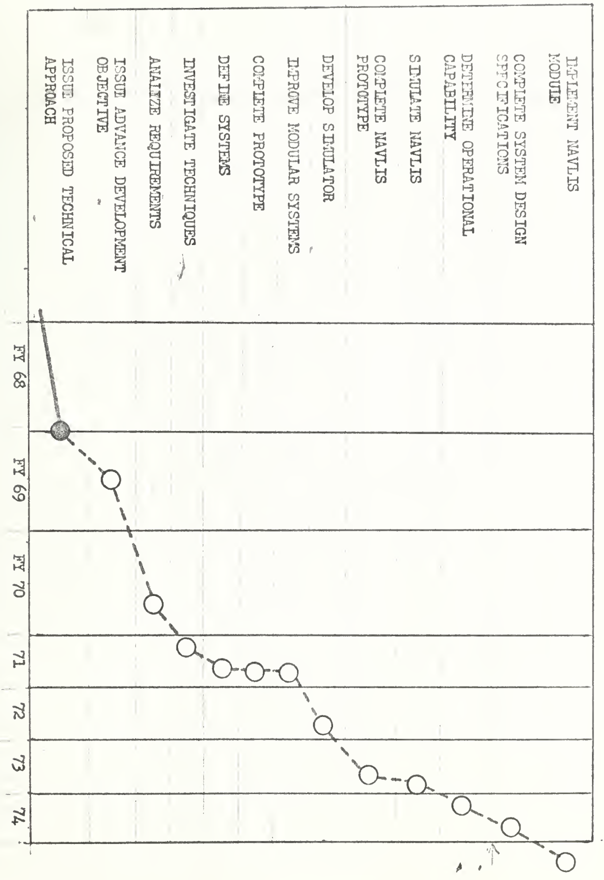

Fig. 9

the information requirements in the material logistic system. Specific advance development objectives are being refined, however, the action milestones indicated by figure 9 are representative.

The requirements analysis is expected to be completed by late fiscal year 1970. The results of the analysis will determine the requirements for management information at various levels of decision activity, the availability of existing communications channels, the criteria for various interfaces, and the necessary standardization guidance. Based upon a knowledge of existing capabilities and requirements, an in depth investigation of various techniques can be initiated, systems defined and a NAVLIS prototype developed. The techniques to be investigated are expected to include the following general categories:

Query

System-sharing

Multi-processing/multi-programming

High volume time sharing

Mass data reduction

Retrieval/display

Data mapping

Decision algorithms and logistic models

Software quality control

Security file protection

Source data automation

Data communications

Human factors/training

The effort to develop a successful total Navy logistic information system does represent a significant element of risk; however, rough estimates, based primarily on subjective judgements, indicate a probability of success that is well above 60%. The risk factor can be monitored as the project progresses with continuous reevaluation of risk and cost factors. There are three major decision points which can be anticipated in the NAVLIS advance development schedule, (1) prior to NAVLIS simulator development, (2) prior to development of NAVLIS prototype, and (3) prior to development of system design specifications. Decisions at these points will be determined by financial projections which are based on actions that have been completed.

It is estimated that NAVLIS project costs through the development of a prototype will be approximately 17-24 million dollars.[10] The expenditure of funds in this amount to develop a prototype can be partially justified by the increased visibility of existing data sources and requirements for information. The effort invested in NAVLIS will provide returns through improvements to current systems and should clearly identify the major causes for a NAVLIS operational requirement.

It is possible that the systems which are now envisioned as components of NAVLIS can be improved sufficiently to enable a natural evolution toward the NAVLIS objectives; also technological developments by 1973, when a NAVLIS prototype would be complete, may result in a radical change from the current trend toward centralization. Numerous other factors such as techniques which are feasible but determined not

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[10] RADM B. H. Bieri, Jr., SC, USN, Speech before Naval Reserve Supply Company 9-7, Ship's Supply Officer Division 9-1, at Chicago, Illinois on November 2, 1967

to be desirable, prohibitive costs, or various considerations of the human element, could result in the increased emphasis on NAVLIS hardware, effecting interfaces through software with minimum attention to hardware, or other major revisions to the NAVLIS conceptual approach, including the remote possibility of complete abandonment. The action milestones for fiscal year 1973 and beyond could be modified or eliminated entirely.

Organizational Changes

NAVLIS will not require major structural changes to the current organization, but desirable changes may be identified. The NAVLIS concept recognizes the multi-directional flow of information in an organization, and is an attempt to integrate this flow throughout the organization. It is unlikely that NAVLIS can integrate all of the information systems which are currently related to the material logistic system, but major information systems can be associated with functional requirements for information. NAVLIS should increase the pressure to restructure organizations in order to provide more effective communications and acquisition of information.

A prerequisite for a totally integrated information system is the knowledge of information requirements for decision activity; the presumed existence of this knowledge suggests the availability of a criteria for evaluating decisions which are made. The NAVLIS concept acknowledges the need for information on interim levels of decision activity as well as operational activity which results from management decisions. The role of decision makers in the organization may be

changed by the increased ability to evaluate decision activity and more accurately distinguish between analytic and synthetic decisions.

NAVLIS can be expected to strengthen the role of the middle management levels of decision activity. As additional emphasis is given to the impact of present decisions on future actions, the need for the interpretative level of decision activity can be expected to increase. Adequate, well structured information flows, which can be used as a basis for rational and realistic planning, will encourage a greater involvement by the higher levels of decision activity. The security which could result from knowledge that more accurate assessment can be made of decision activity throughout the organization, would suggest a tendency toward less involvement with current operations by higher levels of decision activity.

There are very strong arguments that current trends will result in a flat organization with decisions being made by a few at the top and a broad applicative base. These arguments contend that there will be an upward shift in the boundry between planning and operations with a significant amount of the planning responsibility removed from middle management. The assumption is made that most middle management decisions are programmable and can be accomplished by a computer, and that remaining non-programmable decisions could be distributed between top management and a greatly reduced middle management force.[11]

Equally strong arguments, however, support the opposite view and maintain that while routine repetitive decision activity may be eliminated from the middle management role, the amount of non-repetitive

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[11] Steiner, Top Management Planning, p. 509

decision activity will increase in direct proportion.[12] Middle managers will have more time to perform creative and imaginative work within a more forward thinking environment provided by increased decision activity on future actions. Various studies of the impact of computers on middle management indicate that middle management jobs of the future will require more vision, initiative, and knowledge.[13]

The impact on the Navy organization will not be caused directly by NAVLIS, but rather by a tendency to shift management patterns because of the availability of, and degree of reliance on the information structure. For example, results oriented managers might shift from a job management pattern to a goal-oriented management.[14] Conversely, some managers would be expected to change in the opposite direction based on exactly the same set of circumstances. It is not expected that NAVLIS will cause a significant change in the shape of organizations; however, it could result in the wider application and more effective utilization of existing management techniques. The need for a middle manager could become more evident in particular situations based on increased flows of relevant information, the staff technique and project manager approach could be more effectively utilized in special situations. The conceptual model for NAVLIS is not designed to accelerate trends toward centralization nor to promote a trend toward decentralization; rather the intent of NAVLIS is to provide an environment which will enable a manager to emphasize various

[12] Ibid.

[13] Ibid.

[14] Daniel M. Glasner, "Patterns of Management By Results," Business Horizons, February, 1969, p. 37

organizational characteristics based on his style and the existing situation.

Political and Sociological Constraints

References have been made to the prospects for the success of NAVLIS relative to technological, economical, and conceptual feasibility. These factors will be major determinants, but political and sociological constraints will also affect the success of the NAVLIS project. Expenditures for the NAVLIS project may be viewed as direct reductions in resources which could be made available for other requirements. The impact of these reductions will be most significant at the operating level where the initial benefits of NAVLIS will be least obvious. Tangible products from NAVLIS cannot be expected for several years and unless some benefit can be identified for the operating manager, the acceptance of the NAVLIS project may rapidly decline. Despite the identifying title of Navy logistic information system, and the insistence by several officials that NAVLIS is not a management information system, the project is in fact a management information system. Many managers feel that they already have more than sufficient information and may not respond favorably to the diversion of resources for an additional management information capability.

The proponents of the eventual disappearance of middle management argument do make one valid point since this argument implies that the role of the middle manager will change significantly. It does not really matter if resistance stems from a fear of being eliminated or the fear of change, it will provide a major constraint to NAVLIS.

A primary reason for being of the NAVLIS project is the reduction of workload at the operating level. Standardization, investigation of techniques, improvements to existing systems, and other early NAVLIS efforts may require a temporary increase in the workload of the operating forces. This increased work may only involve replies to correspondence or explanations of existing procedures, but it will be extremely difficult to rationalize the requirements at the operating level.

There are no general rules for making choices which provide an optimum balance between desirability and feasibility. The commander may acknowledge the feasibility of NAVLIS, but his acceptance will be influenced by his determination of the desirability of the project for his particular level of decision activity. Many managers do not regard the prospect of higher levels of decision activity with complete access to all data from lower levels as a desirable situation. A manager is not currently expected to explain in total and complete detail the reasons for each major decision; additionally, it is generally recognized that most managers could not completely describe their decision process even if asked.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The original Navy goal of an integrated information system for logistics envisioned information as observable phenomena, which could be manipulated by a computer and used to satisfy the needs of decision makers in the logistic system. ADP systems were allowed to develop within respective management control boundaries, based on the premise that information requirements for successively higher levels of decision activity could be readily identified and coordinated. The application of improved technology emphasized the complexities of information in an organization, and indicated the need to reevaluate previously accepted conceptual relationships. The original approach to achieve an integrated information system for logistics has not been successful.

Information systems describe a conceptual relationship between a source of data and the existence of knowledge. Abstraction, development of data, and analysis of data are interrelated processes which may produce information. The association of an information system with an organization implies a desire to influence the processes which produce information, in order to establish common meanings among the members of the organization. The system of processes which produce

information in an organization to influence goal-oriented decision activity is a management information system. NAVLIS is a project to design and develop a management information system for material logistics.

Information systems are dependent variables and are effected by situational needs of individuals. The goals of the organization provide a framework for the production of management information; however, individual decision activity may reflect the impact of information systems that are not structured by the organization. A total management information system implies the integration of all processes by a manager to produce information. The integration of management information systems can be facilitated by relating each source of data to a requirement for information. The scope and complexity of the material logistic system may preclude the identification of each data source and the establishment of appropriate relationships based on the current NAVLIS precepts.

NAVLIS is the first attempt by the Navy to view the material logistics system as an integrated whole. The precepts for the NAVLIS project suggest the development of a common network of processes for the information requirements of managers in the material logistic system. NAVLIS is based on a new perspective of the material logistic system, but the proposed technical approach is basically the same as the traditional Navy approach for design and development of information systems.

The original Navy plan for integrated information systems established the policy of system design and development within respective

management control boundaries. Information systems which have been developed reflect the total systems concept within each area of management control, and are designed to relate the sources of data to respective levels of decision activity. The existing information systems do not relate the goals for material logistics to the requirements for information at appropriate levels of decision activity. The NAVLIS concept envisions material logistics as a functional area, and expands the boundary of management control. A new approach, however, would require the determination of the information requirements and their relationship to goals and objectives for material logistics. The framework for an integrated material logistic information system can be provided by the goals of the system which material logistics is intended to support. These goals have not been explicitly stated.

The multiple information systems that currently exist do not represent a need for additional management information, but indicate that managers have been unable to relate the existing volume of empirical data to an appropriate system. The analysis process for the material logistic information system is inadequate. The NAVLIS conceptual approach proposes to reduce the volume of data and to provide a parallel information system which will supplement the existing processes for producing information.

Every aspect of the material logistic system is a potential source of data for an information system, but comprehensive knowledge about each aspect is not required to achieve the goals of material logistics. A total material logistic information system can be viewed as a system with reasonable relationships among major and minor systems

which influence goal-oriented decision activity.

A system based on NAVLIS precepts is feasible, but the desirability of the system will depend upon the management style of the managers who use the system. It is unlikely that a management information system can be developed which will suit the style of every manager; however, a system can be developed which will encourage the manager to conform to a particular style. NAVLIS will influence the style of some managers, and may increase the dependency on higher levels of decision activity. Data cannot be aggregated without concurrent analysis and association with a system, the quality of analysis will be a major determinant of NAVLIS impact on the managers of the material logistic system.

A penetrating and orderly study of the Navy material logistic system in its entirety is required. Explicit goals for the logistic system should be developed to provide a basis for the study, and to enable the design of an information system which will be responsive to the needs of managers. The objectives of the NAVLIS project cannot be achieved unless the requirements for information are determined for each level of decision activity in the material logistic system. The information requirements are dependent upon the function of material logistics, and also upon the relationship of each element in the material logistic system to the survival of the system.

There is a management information crisis in the material logistic system. This crisis can be alleviated by a micro-input, multi-user, communication, storage, and decision complex such as NAVLIS.

However, unless goals are established which clearly identify the objectives of the material logistic system, NAVLIS will only consolidate the current volume of data and facilitate a faster accumulation and transmittal of conventional data.

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